DOCUMENT RESUME

ED 451 694 EF 005 929

AUTHOR	Noson, Linda Lawrance; Perbix, Todd W.
TITLE	School Facilities Manual: Nonstructural Protection Guide. Safer Schools, Earthquake Hazards, Nonstructural. Second Edition.
INSTITUTION	Seattle Public Schools, WA.; Washington Office of the State Superintendent of Public Instruction, Olympia.
SPONS AGENCY	Federal Emergency Management Agency, Washington, DC.
PUB DATE	2000-05-00
NOTE	165p.; Supercedes July 1989 Edition. Funded by the Seattle Project Impact Program initiated by FEMA.
AVAILABLE FROM	For full text: http://www.k12.wa.us/facilities.
PUB TYPE	Guides - Non-Classroom (055)
EDRS PRICE	MF01/PC07 Plus Postage.
DESCRIPTORS	*Earthquakes; Elementary Secondary Education; *Guidelines; Public Schools; *School Safety
IDENTIFIERS	*Nonstructural Elements (Construction); Washington

ABSTRACT

This guide addresses the strengthening of nonstructural elements of a school building to resist earthquake-induced damaged and improve school building safety in Washington State regions with notable earthquake activity. Nonstructural elements include the decorative details and those functional building parts and contents which support the activities in, and the performance of, the building such as mechanical and electrical systems, furnishings and equipment, and necessary hazardous materials. The first section discusses earthquake activity in Washington, earthquake-induced damage to Washington schools, the causes of earthquake damage, the school district nonstructural protection program, and the use of school site teams. The second section presents inventory forms and inventory process for nonstructural elements. A revision of this section is included at the end of the guide. The third section provides the details for protecting nonstructural elements from earthquake-induced damage. Appendices include a vendors list, a draft list of district manager access to database tables, and an examination of the Seattle Project Impact Pilot Test of the Seattle Public Schools Nonstructural Protection Program. (Contains 10 references.) (GR)

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SCHOOL FACILITIES MANUAL
Nonstructural Protection Guide

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EF 005 929

Second Edition
May 2000

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Disclaimer

This Guide provides information for school district staff and parents on how to establish a program to identify and strengthen nonstructural building elements to resist life-threatening failures during earthquake shaking. The primary goal of this Guide is to support the implementation of a school nonstructural earthquake protection program to improve the safety of students, staff, parents, and other school visitors. However, please note that *"The state of the art of earthquake engineering is not sufficiently developed to perfectly predict the performance of nonstructural elements or to guarantee adequate earthquake protection if [the guidelines in th[illegible] manual] or other guidelines are followed. Professional expertise is recommended to increase the probability that intended levels of earthquake protection will be achieved. Liability for any losses that may occur in an earthquake or as a result of using this [manual] is specifically disclaimed."* (Reducing the Risks of Nonstructural Earthquake Damage: A Practical Guide, FEMA, 1994, p. vi)

Cover Photograph: Failure of pendant light fixtures. The failure of pendant light fixtures in the Dawson Elementary School library in Coalinga, California, after the magnitude 6.7 earthquake on May 2, 1983. This failure would have caused many injuries if the library had been occupied (Photo credit: Earthquake Engineering Research Institute)

SCHOOL FACILITIES MANUAL
Nonstructural Protection Guide

SAFER SCHOOLS
EARTHQUAKE HAZARDS
NONSTRUCTURAL

Second Edition
Supercedes July 1989 Edition

Second Edition by Linda Lawrance Noson (AMEC Earth & Environmental) and Todd W. Perbix (Perbix Bykonen Engineers) for the Seattle Public Schools with funding from the Seattle Project Impact program initiated by FEMA

First Edition prepared by Linda Lawrance Noson and Todd W. Perbix of Ratti Swenson Perbix for the Federal Emergency Management Agency (FEMA) and issued by the Washington Office of the Superintendent of Public Instruction

Acknowledgments

Seattle Project Impact provided funding and support to the Seattle Public Schools to prepare the *Nonstructural Protection Guide*. Seattle Project Impact is part of a national focus on local private/public partnerships initiated by the Federal Emergency Management Agency (FEMA). The goal of FEMA's Project Impact program is to foster the development of disaster-resistant communities throughout the United States.

This guide was originally prepared by Linda Lawrance Noson and Todd W. Perbix of Ratti Swenson Perbix under contract to the Federal Emergency Management Agency (FEMA). It was issued to Washington school districts by the Washington Office of the Superintendent of Public Instruction (OSPI) in 1989 under the title *Nonstructural Earthquake Hazard Manual*. The manual was part of the Safer Schools section of the OSPI *School Facilities Development Procedures Manual*. The *Nonstructural Protection Guide* authored by Noson (AGRA Earth & Environmental) and Perbix (Perbix-Bykonen Engineers) is an update of the 1989 manual. It is being issued jointly by OSPI and the Seattle Public Schools.

Many individuals and organizations contributed to this revision. In particular, Ed Heller (Director of Maintenance) and Theresa Salmon (Site Coordinator) from the Seattle School District deserve special thanks for their efforts and for their contributions to this documents. Larry Farrar, Director of Safety and Security, and Peggy McElvoy, Safety Coordinator lead the Seattle School Districts emergency preparedness program, which complements the mitigation actions recommended in the guide. Staff from the City of Seattle Emergency Management provided leadership and project oversight. Members of the Seattle Project Impact organizing committee and the Washington State School Facilities Cost Advisory Board reviewed the document. Skilling Ward Magnusson Barkshire provided word processing and technical engineering services to update the graphics for the nonstructural details. Kitty Reed, formerly technical editor for the Washington Department of Natural Resources, expertly guided the authors in improving the clarity and usability of the document. Any failure to achieve those goals reflects our shortcomings and not those of the editor or reviewers. The authors would particularly like to thank Grace Clark Weaver for word processing and production services.

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SCHOOL FACILITIES MANUAL
Nonstructural Protection Guide

SECTION A

BACKGROUND INFORMATION

INTRODUCTION

Purpose

Strengthening the nonstructural elements of a school building to resist earthquake-induced damage is an important step toward improving the safety of the school community in regions with notable earthquake activity. Strengthening nonstructural elements also tends to reduce property damage and speed the restoration of school programs following an earthquake emergency.

The Nonstructural Protection Guide provides information on how to establish a district-wide program to identify and strengthen nonstructural elements commonly found in school buildings. The Nonstructural Protection Guide was prepared to accompany the Washington Office of the Superintendent of Public Instruction (OSPI) School Facilities Manual.

Nonstructural elements of a building

The nonstructural elements of a building include the decorative details and those functional building parts and contents which support the activities in, and the performance of, the building. Nonstructural elements make it possible to enjoy and use a building safely, comfortably, and efficiently as distinguished from the structural elements that maintain the physical integrity of the building.

Earthquake induced damage to the nonstructural elements of a building generally does not undermine the capability of the structural elements to support the building. Structural elements such as beams, columns, floors, walls, and foundation, are designed to resist the expected pushes and pulls of gravity, wind, earthquakes, and other types of loads in order to prevent structural collapse. Figure 1 shows examples of the nonstructural and structural elements of a building.

Typical nonstructural elements of a building include:

Architectural Elements

- Cladding
- Veneer
- Windows and partition walls
- Parapets and cornices
- Canopies and walkways
- Stairways
- Water towers

Mechanical Systems

- Heating, ventilation, and air-conditioning
- Fire protection
- Elevators
- Water and sewage

Electrical Systems

- Transformers
- Lighting
- Emergency power

Furnishings and Equipment

- Computers
- File cabinets
- Shelving
- Display cabinets
- Shop equipment
- Lab equipment
- Kitchen appliances
- Vending machines

Hazardous Materials

- Natural gas
- Chemicals
- Asbestos, lead

Benefits of strengthening nonstructural elements

Securing the nonstructural elements improves the safety and security of the school community during an earthquake emergency:

- Reduces casualties
- Helps maintain safe and clear exit ways for evacuation and to access the building
- Reduces dangerous chemical spills, fires, and gas leaks
- Improves the likelihood of using the building as a shelter following the earthquake

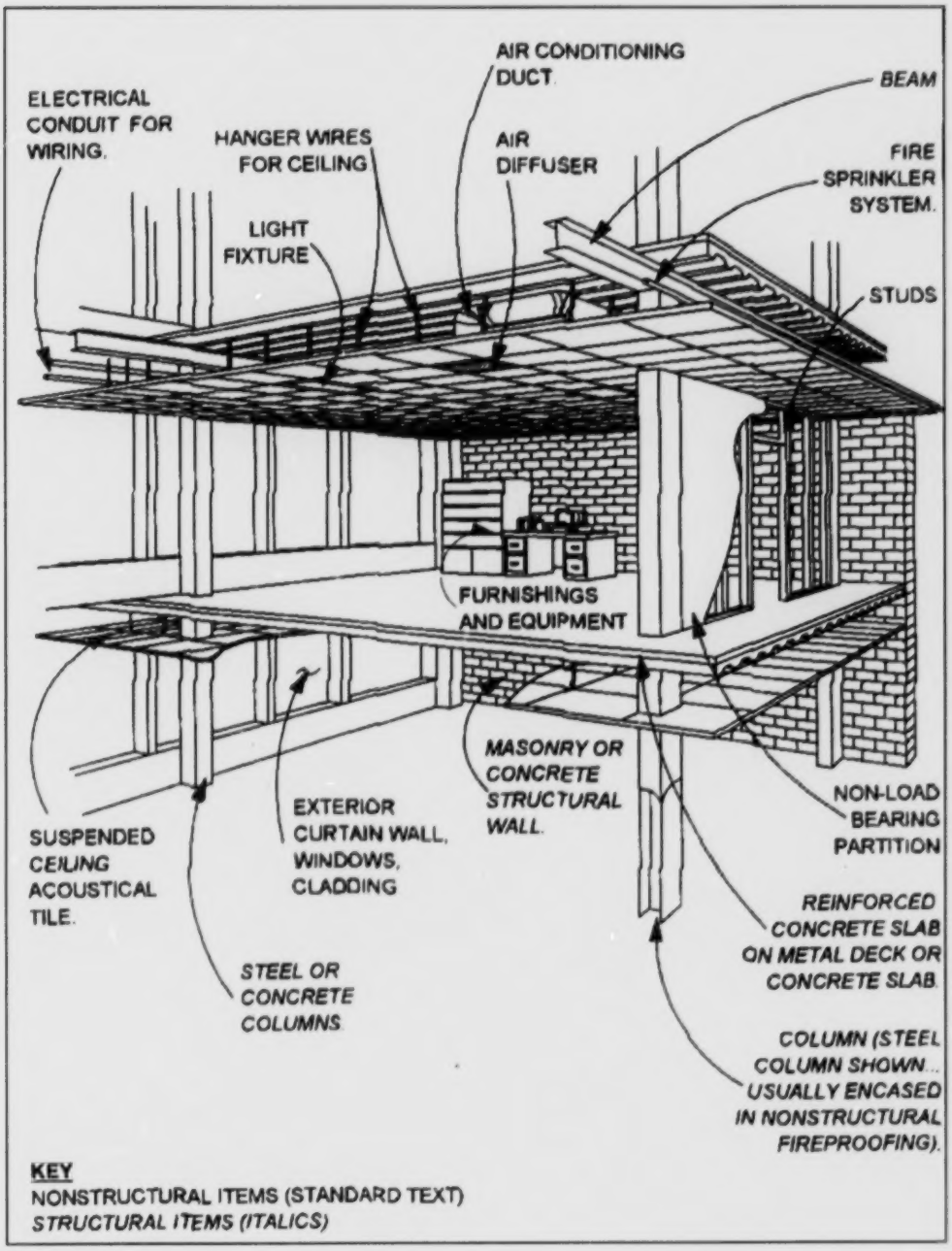
Securing the nonstructural elements also improves the safety and security of the school community during normal school operations:

- Bookshelves and lockers attached to walls reduce vandalism and improve the safety of exit routes
- Locked storage rooms and secured equipment discourage theft
- Safety films on glass make access to the building by intruders more difficult
- Glass safety films may be tinted to improve energy conservation
- Anchored vending machines prevent casualties caused by overturning during an earthquake or if shaken by users
- Staff, parents, and students who inventory school areas for nonstructural earthquake hazards will also be learning skills that will enable them to make their homes and businesses safer
- The inventory promotes teamwork among the school community and helps team members become more familiar with building areas
- Secured and properly stored chemicals help reduce spills during normal classroom use

Securing nonstructural elements tends to foster recovery:

- Repair of earthquake induced damage to nonstructural elements can cost millions of dollars and keep schools closed even when no structural damage has occurred

Figure 1
Nonstructural And Structural Components of a Typical Building (FEMA 1994).



Limitations of the Nonstructural Protection Guide

The many nonstructural elements in a building and our imperfect understanding of both regional earthquake hazards and their impacts on buildings make the elimination of all damage to nonstructural building elements an unrealistic and expensive goal.

Some of the nonstructural elements described in this Guide require specialized expertise to identify the specific earthquake hazard and to develop appropriate nonstructural protection measures. This expertise may not be available among school district personnel. Many of these elements are included in the Guide as a means of increasing awareness of the hazards they present and the types of outside services that may be needed to reduce that hazard.

Information in the Guide is based on current earthquake retrofit practice and standards for existing buildings. Practice and standard changes as new information is available. No building or its elements can be made "earthquake proof" due to the many variables involved in producing earthquake damage. However, the strengthening methods in this Guide can help make schools more resistant to earthquake induced damage and improve the safety of building occupants.

Implementation of the nonstructural protection measures in this Guide must be complete before the ground begins to shake. These measures, which reduce the severity of loss through strengthening the resistance of nonstructural elements to earthquake induced damage, are called mitigation measures. The earthquake is a test of the success of implemented mitigation measures to resist damage. Nonstructural protection is one element of a school facilities mitigation program.

School emergency preparedness

This Guide does not focus on emergency response actions taken after an earthquake to rescue victims, stabilize buildings, and salvage facilities. School staff, students, and visitors must be ready to take immediate protective actions during the sudden on-set of earthquakes and other emergencies that may occur when schools are in session. A school emergency preparedness program to develop an effective emergency response capability is a necessary complement to a school facilities mitigation program.

The school emergency preparedness program should include a section that addresses the unique issues related to earthquakes:

- Earthquake-specific response procedures
- Earthquake drills and exercises
- Emergency supplies and equipment on site
- Information for staff and parents about home earthquake safety
- An educational program for staff and students and a psychological recovery plan

Getting help

City, county, or state emergency managers may be able to assist the school district in the development of a school nonstructural earthquake strengthening and preparedness program. Local emergency managers can help to: (1) identify planning and earthquake hazard reduction resources, (2) explain what local governments expect of schools during an emergency, and (3) assist with developing school emergency response drills and exercises. The coordination of school emergency plans with the city or county emergency plan is an important part of establishing an effective community response capability.

Nonstructural manual content

This Guide addresses:

- Washington Earthquake Hazards.
- Earthquake-Induced Damage to Washington Schools.
- Causes of Earthquake Damage.

- District Nonstructural Protection Program. Guidance is provided on developing and managing an on-going, Nonstructural Protection Program to reduce earthquake-induced hazards in school buildings.
- School Site Teams. Involvement of school site teams consisting of staff, parents, and students in inventorying nonstructural earthquake hazards and implementation of nonstructural protection measures.
- School Nonstructural Inventory (Section B) Directions and forms are provided to complete a comprehensive inventory of school nonstructural earthquake hazards.
- Nonstructural Protection Details (Section C) Drawings and implementation instructions show selected examples of methods and supplies needed to strengthen nonstructural elements to resist earthquake-induced damage.
- Appendices contain:
  - — References Cited.
  - — Lists of vendors selling nonstructural protection supplies.

WASHINGTON EARTHQUAKE HAZARDS

What is an earthquake?

An earthquake is the ground shaking caused by the sudden movement of rock along a fracture in the Earth's brittle outer layer. This sudden slip, referred to as faulting, releases waves of energy that radiate outward in all directions from the area of initial movement. Most faulting and associated earthquakes occur in response to temperature-driven movements of rock that is deep inside the Earth. This slow movement pushes and pulls against the Earth's outer layer.

Why, how big, and where do we have earthquakes in Washington?

Historically, earthquake activity has been most active and damaging west of the Cascade Range. However, all areas of the state are exposed to the threat of at least minor earthquake damage. The Washington Department of Natural Resources has a number of publications on Washington earthquakes. Washington Earthquake Hazards (Noson, et al 1988) provides a summary of state hazards and risks. A brief discussion of state hazards is provided below.

Washington is well known for its beautiful mountains, lakes, and forests. The same active geologic forces that shaped this landscape also generate earthquakes. The earthquake potential in Washington is largely determined by the interaction of three large, slowly moving slabs of rock, called tectonic plates. The relative movements of these plates generate Washington earthquakes in three source areas. Each of these source areas has unique earthquake characteristics:

- Deep earthquakes as strong as magnitude (M) of 7.5 (see paragraph titled How Is Earthquake Size Measured?) occur beneath Puget Sound in the Juan de Fuca Plate and are generated as the plate stretches and sinks northeastward below the North America Plate. Notable historic deep earthquakes include the 1949 Olympia (M = 7.1) and 1965 Seattle-Tacoma (M = 6.5) earthquakes.
- Shallow crustal earthquakes occur in Western and Eastern Washington in the North America Plate. Notable historic shallow earthquakes include the 1872 North Cascades (M = 7 to 7.5), the 1100 Seattle Fault (M = 7 to 7.5), and the 1936 Walla Walla (M = 6) earthquakes.
- Earthquakes of more than M = 8 in the inclined boundary where the North America Plate and the Juan de Fuca Plate overlap, called the Subduction Zone. Notable earthquakes along this boundary include the 18th Century Cascadia Earthquake (M =8 to M = 9).

How often do Washington earthquakes occur?

Several thousand earthquakes occur in Washington each year. A dozen or more of these shake the Earth's surface hard enough for the vibrations to be felt by humans.

Deep Earthquakes: Every few decades, deep Puget Sound earthquakes rock local Washington communities hard enough to crumble older brick buildings, shift wood-frame buildings off their foundations, and disrupt utility and transportation systems. Every few hundred years larger deep earthquakes beneath Puget Sound cause significant damage to older buildings and more limited damage to modern buildings in communities throughout the state.

Subduction Zone Earthquakes: Every few hundred years huge subduction zone earthquakes along Washington's coastal margins permanently shift the land, dropping some areas by as much as 6 feet causing inundation of marsh grasses forests and shoreline communities, and elevating other areas potentially leaving marine facilities high and dry. These earthquakes can generate crushing water waves (tsunamis). Shaking caused by subduction zone earthquakes is expected to be strong enough to damage communities over the entire Cascadia Region from British Columbia to Northern California.

Shallow Earthquakes: Geologic studies show that 1,000 years ago a large, shallow western Washington earthquake much stronger than any we have experienced historically left evidence of intense shaking, dramatic movement of the Earth's surface, landslides, ground settlement, and tsunamis. A repeat of a major shallow earthquake on the Seattle Fault or other similar faults would cause extensive damage to Washington communities similar to the devastation caused in Kobe, Japan in 1994.

How is earthquake size measured?

Magnitude: Earthquake size or magnitude can be determined using an instrument called a seismograph. This instrument measures the movement of the Earth's surface by recording the radiating earthquake waves. Each whole-number magnitude increase represents a ten-fold increase in the up and down motion recorded by the seismograph. An M = 6 earthquake causes 10 times the recorded motion of an M = 5 and 100 times the motion of an M = 4 earthquake.

The magnitude may be used to calculate the amount of energy released by the earthquake. Each whole-number increase in magnitude corresponds to an energy increase of about 32 times the lower magnitude value. An M = 6 earthquake releases about 30 times the energy of a M = 5 and nearly 1,000 times the energy of a M = 4 earthquake

As earthquakes increase in size, the movement of the earth in response to the earthquake waves saturates. That is the ground motion no longer increases in a way directly related to the increased size of the earthquake. A different method of determining magnitude based on the number of factors, such as area of slip, is used to calculate the size of earthquakes generally greater than M = 8.

Intensity: Earthquake size may also be determined using a subjective scale of observed damage. This method was used before the installation of seismographs and before the development of the Richter Magnitude Scale. An example is the Modified Mercalli Intensity (MMI) Scale (Table 1) first published in 1931. Defining the intensity of an earthquake is similar to describing the brightness of a light bulb at a particular location in a room. What is observed depends not only on the light bulb's "magnitude" as measured by the number of watts, but also on the characteristics at any particular location that might affect the light's brightness. Similarly, the intensity of damage observed at a specific building depends upon a number of factors, such as the earthquake's magnitude, distance from the fault generating the earthquake, type of geologic materials underneath the building, type of building construction, age of construction, and other attributes. Over time the MMI scale has been modified to address changes in building types.

All these possible variations in damage result in a single earthquake being capable of producing intensities ranging from *not felt at a particular location* (MMI = I) to *causing catastrophic damage* (MMI = XII) at another place. Historical records generally list an earthquake's maximum observed intensity and the size of the area in which the earthquake was felt.

The maximum reported intensity for the 1965 Seattle-Tacoma Earthquake was MMI = VII. The maximum intensity reported for the 1949 Olympia earthquake was MMI = VIII. Both earthquakes were felt widely from western Canada south to Western Oregon.

Historic earthquakes in eastern Washington have generally been less frequent, more localized and of smaller intensity than those observed west of the Cascades. The 1936 Walla Walla, Earthquake, however, had a maximum intensity of MMI = VII, indicating that significant earthquake hazards do occur in eastern Washington.

Table 1
Modified Mercalli Intensity Scale

Scale	Description
I.	Not felt except by a very few people under especially favorable circumstances.
II.	Felt only by a few people at rest, especially on upper floors of buildings. Delicately suspended objects may swing.
III.	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. The vibration is similar to that caused by the passing of a truck. People often estimate the duration.
IV.	Felt indoors by many and outdoors by a few. Some are awakened. Dishes, windows, and doors are disturbed; walls make cracking sound. The sensation is like a heavy truck striking a building. Standing motor cars rock noticeably.
V.	Felt by nearly everyone; many are awakened. Some dishes and windows are broken. Unstable objects may be overturned. Pendulum clocks may stop. ***[MMI = V generally marks the beginning of damage to nonstructural elements.]***
VI.	Felt by all and many are frightened. Some heavy furniture is moved; there can be a few instances of fallen plaster. Damage is slight.
VII.	[Structural] damage is negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly built structures. Some chimneys can be broken. Motion is noticed by persons driving motor cars. ***[MMI = VII generally marks the beginning of possible structural damage to modern buildings. This is the maximum intensity reported for the 1965 Seattle-Tacoma Earthquake.]***
VIII.	Structural damage is slight in specially designed structures; considerable in ordinary substantial buildings, with partial collapse; great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, and walls common. Heavy furniture is overturned. ***[This is the maximum intensity noted for the 1949 Olympia Earthquake.]***
IX.	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings may be shifted off foundations.
X.	Some well-built wooden structures are destroyed; most masonry and frame structures are destroyed along with their foundations. Rails are bent.
XI.	Few, if any (masonry) structures remain standing. Bridges are destroyed. Rails are bent greatly.
XII.	Damage total. Lines of sight and level are distorted. Objects are thrown into the air.

Taken from a pamphlet titled "The Severity of an Earthquake" prepared by the US Geological Survey in 1986. See Wood and Neumann (1931) for complete details. Comments in italics added by the authors.

EARTHQUAKE-INDUCED DAMAGE TO WASHINGTON SCHOOLS

Introduction

Substantial damage to public and private schools in the 1949 and 1965 earthquakes in western Washington heightened awareness of the vulnerability of state schools. The severe damage sustained by older, unreinforced masonry school buildings and the deaths of two students called attention to the need for structural strengthening or replacement of many older schools.

There is no state requirement that school districts identify structural and nonstructural earthquake hazards or implement programs to improve the earthquake safety of school buildings. But a number of school districts are strengthening their buildings to improve student safety in response to concerns expressed by district managers, teachers, and parents.

The Seattle Public School District completed a series of building evaluations, facility utilization studies, and seismic evaluations from the mid-60s to the mid-90s (Perbix and Noson, 1996). In 1998 the Seattle School District was in the final phase of implementing a multi-year capital improvement program addressing potential structural earthquake hazards in city school buildings. Seattle is now moving forward with a program to secure nonstructural elements.

1949 Earthquake Damage

The April 1949 Olympia earthquake (M = 7.1; MMI = VIII) resulted in the closure of 30 Washington schools normally serving more than 10,000 students (Table 2). Ten of these schools were condemned and permanently closed. Gonen and Hawkins (1974) report 1949 losses to Washington schools of $10 million or about $60 million using the Consumer Price Index to adjust to 1998 dollar values. Total estimated property losses for this earthquake ranged from about $100 to 165 million dollars (1998 dollars; $15 to 25 million 1949 dollars).

Casualties related to the earthquake included the death of the student body president at Castle Rock High and a small child killed at Lowell Elementary School in Tacoma. Both were killed by bricks dislodged from the exterior of the building. The Seattle Public Schools were closed for spring holidays, which prevented loss of life to staff and students from the extensive fall of bricks, chimneys, and parapets on to many school walkways and playgrounds experienced in Seattle.

Costs to replace and repair 21 Seattle school buildings damaged in the 1949 earthquake represented nearly one half of the total damage reported for Washington State Schools. Three schools were condemned (Lafayette Elementary School, Central Grade School, and Cascade Grade School) and five temporarily closed for repairs (Lincoln High, Queen Anne High, Roosevelt High, West Seattle High, and Whitworth Grade School). Repair and replacement costs for these eight schools were over $25 million (1998 dollars; $4 million 1949 dollars). The remaining 14 schools required over $3 million in repairs (1998 dollars; $500,000 1949 dollars)).

1965 Earthquake Damage

The April 1965 Seattle-Tacoma Earthquake, although a less powerful earthquake than the 1949 earthquake, had a similar damage pattern. Over $60 million (1998 dollars; $12 million 1965 dollars) in estimated property loss was reported for this earthquake (Gonen and Hawkins 1974). Table 3 lists damage to Seattle school buildings. Eight Seattle public schools were closed. Two schools in West Seattle, including West Alki School, sustained severe damage.

Table 2.
Selected Damage In Washington Communities
From 1949 Olympia Earthquake

Community	Impact
Auburn	Junior high school was condemned. Four blocks of downtown business district damaged severely. Fall of parapet walls and many chimneys. Small objects overturned. Books fell. Dishes broken.
Castle Rock	Castle Rock High School damaged severely, with brick and masonry falling on children (one fatality). Upper wall over entrance to school building fell. Considerable damage to brick masonry and concrete buildings. Chimneys fell. Dishes, windows, and furniture broken.
Centralia	Over 30 businesses and school buildings were very severely to moderately damaged. Collapse of building walls and many chimneys. Water mains broken. Two schools permanently closed. Water and sand spouted from the ground. Damage to water intake. Telephone lines twisted together for many miles.
Chehalis	Damage was considerable to wood, brick, masonry, and concrete buildings. Most downtown buildings, schools, and churches damaged. Brick damaged most severely. City library condemned.
Longview	High school water main broke and beams cracked in the cafeteria. Light damage to water main and electric transmission line. Several refrigerators overturned. Water and sand spouted from the ground and up into basements.
Olympia	Nearly all large buildings were damaged with cracked or fallen walls and cracked or fallen plaster; water and gas mains broken. All schools evacuated by fire marshal for inspection. Eight capitol buildings damaged; two closed. Fifty percent of chimneys down or severely damaged.
Puyallup	High school was damaged severely; stage collapsed in auditorium. Nearly every house chimney toppled at roofline; several houses jarred off foundations. Four buildings collapsed. Water mains were broken. Several basement floors were raised several feet. Basements filled with water and sand.
Seattle	Damage to 21 schools, with five closed temporarily and three condemned. Typical damage included failure of gables, parapet walls, and exterior ornamentation and collapsed chimneys. Many houses on filled ground demolished. Collapse of the top of a radio tower. Heavy damage to docks and stores waiting for shipment. Many water mains in soft ground broken, and many basements flooded. Telephone and power service temporarily interrupted. Bookcases overturned.
Tacoma	Three schools damaged and closed for repairs. Few homes escaped some damage. Several houses slid into Puget Sound. Railroad bridges south of Tacoma thrown out of line, and traffic held up for hours. Railroad tracks kinked, buckled, and sank 4 feet in one place. Tremendous rock slide followed earthquake.
Tenino	Every business and house suffered some damage. Grade school heavily damaged. Damage considerable to brick.

(Information from U.S. Department of Commerce, 1949)

Table 3.
Damage To Selected Seattle School Buildings
From The 1965 Seattle-Tacoma Earthquake

Name of School	Description of Damage
Ballard High School	Damage was confined to the auditorium where a ceiling arch was bent and a study wall twisted.
Broadview Elementary School	Part of an older exterior brick wall fell.
Colman Elementary School	A chimney was damaged; part of the masonry gables at the entrance fell; the front wall was damaged.
Franklin High School	Parts of cornices on four corners of the building fell; the lunchroom ceiling was cracked; hallway and stairwells were damaged. All fire alarms were short-circuited and activated.
Gatewood Elementary School	Gables fell.
Leshi Elementary School	Gables fell.
Madison Junior High School	A chimney collapsed, and masonry fell at the entrance; a water line broke.
Queen Anne High School	Walls were cracked.
St. Joseph's School	Pieces of cornices fell from the front of the building.
University of Washington	Minor damage occurred to the Mechanical Engineering Building, including a broken electric cable. Minor cracks were observed on the fourth floor of the new library.
West Alki Elementary School	The 60-foot brick chimney stack fell through the roof down into the boiler room; x-cracks were found in the unreinforced sand-lime mortar brickwork in the 1914 wing; stairs were shifted; the north wall of the new wing moved outward.
West Seattle High School	Walls throughout the school were severely cracked. Exterior and interior walls of the auditorium were cracked.

(Information from Thorsen, 1986)

CAUSES OF EARTHQUAKE DAMAGE

Introduction

Earthquakes shake the ground in all directions. Because of this multi-directional shaking, the structural and nonstructural elements of a building must be specially designed to resist earthquake forces in a variety of directions. Structural and nonstructural elements of a building that are not secured to resist expected up and down and side-to-side earthquake shaking pose a hazard to building occupants.

Structural damage

The structural elements of a building must be designed and constructed to support heavy weights under the force of gravity. Structural elements of Washington buildings generally have sufficient strength to prevent collapse due to vertical earthquake motions. However, special earthquake-resistant design is often needed to strengthen structural elements to resist lateral or side-to-side earthquake motions.

Earthquake-resistant design requirements were absent from local Washington building codes before 1952, limited and largely incomplete from 1952-1975, and generally not standard practice in all Washington communities until after 1980 (Seattle Department of Construction and Land Use, 1999). Therefore, the structural elements of Washington schools built prior to 1952 are particularly vulnerable to earthquake shaking. More modern Washington schools may still have earthquake design deficiencies that could result in severe damage to the structural system during an earthquake. Damage to structural elements may result in partial or complete building collapse.

School facility managers should note that a building that does successfully meet the building code objective to protect building occupants from partial or total building collapse may still need to be torn down after a major earthquake. A school building that does not collapse, may still sustain severe damage to structural and nonstructural elements. This damage may endanger lives, result in building closure, and generate repair costs equal to the cost of building replacement.

Nonstructural damage

Nonstructural elements can be vulnerable to damage from both vertical and lateral earthquake motions. When an earthquake shakes a building, the result can be:

- **Distortion and damage** to nonstructural elements, such as windows, partition walls, and elevators, caused as the shape of the surrounding building deforms in response to earthquake shaking (Figures 2 to 5).
- **Sliding and overturning** of book shelves, file cabinets, mechanical equipment and many other types of furnishings and equipment (Figures 6 to 9).
- **Falling of items** from counters, desks, and shelves (Figure 10).
- **Swaying and shaking** of suspended elements like piping and light fixtures resulting in breaks, leaks, and falls (Figure 11 and 12).

Earthquake-resistant design of nonstructural elements was generally not a major concern in local or national building codes before 1980. Even in the most recent building codes, only a few nonstructural elements must be designed to resist earthquake damage. Therefore, the nonstructural elements in most buildings in the United States remain vulnerable to damage during earthquake shaking.

Why be concerned about nonstructural damage?

Even minor to moderate earthquake shaking may damage nonstructural building elements, possibly resulting in injuries and loss of life. Such light shaking occurs much more frequently than the vigorous shaking that accompanies major earthquakes. The general lack of earthquake-resistant design requirements for nonstructural elements in today's building code further increases the potential for damage and injury. Consider the following effects of nonstructural earthquake damage:

- The Olive View Medical Center performed well structurally in the 1994 Northridge Earthquake (M = 6.7), but damage to equipment and sprinklers resulted in the evacuation of patients (Earthquake Engineering Research Institute, 1994).
- Differences in movement between rigid fire sprinkler systems and more flexible suspended ceilings damaged sprinkler heads resulted in extensive flooding during the 1989 Loma Prieta earthquake, even in structures with no structural damage (Dames & Moore 1989).
- Public school buildings generally performed well structurally in the Northridge earthquake, with no structural collapses. Most damage was nonstructural. Property loss to the Los Angeles Unified School District of $700 million was reported (EERI 1994).
- Damage to nonstructural parts of a building may delay emergency response actions by blocking exits with debris, disrupting communications, and destroying the capacity to fight fires.
- Damage to electric power systems can cause loss of electrical service resulting in failure of lighting, communications, alarms, pumps, and other power dependent equipment. Fluctuations in power may damage equipment.
- After the earthquake, nonstructural damage may prevent building use even in the absence of structural damage. The costs to repair nonstructural earthquake damage can equal the cost of building replacement.

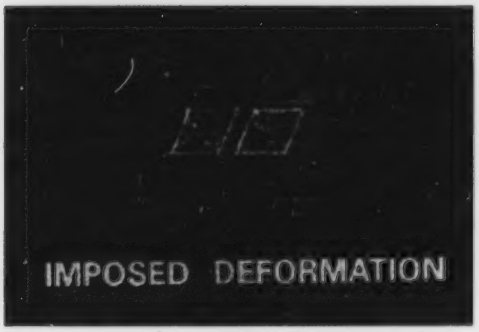


Figure 2. Imposed deformation diagram. Vertically oriented built-in nonstructural components, such as full-height partitions or windows, are vulnerable to deformation imposed by the drift of the structure as it undergoes lateral loads during the earthquake (Graphic credit: Earthquake Engineering Research Institute (EERI), Federal Emergency Management Agency).

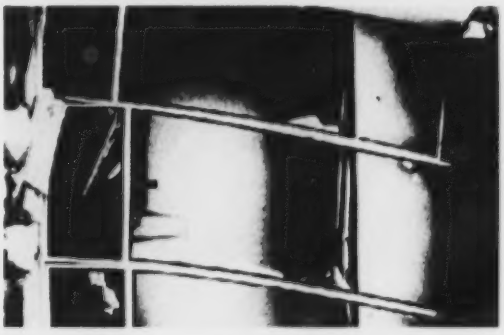


Figure 3. Broken windows, close-up view. A graphic example of the result of severe drift experienced by a concrete structure in the 1964 Alaska earthquake and the resulting failure of the glass panes (photo credit: EERI, John F. Meehan).

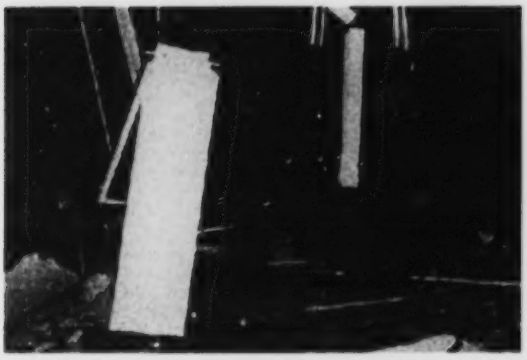


Figure 4. Fallen light fixture. These light fixtures, which were supported by the hung ceiling, fell when the ceiling distorted in the 1971 San Fernando Earthquake. The typical safety measure for fluorescent fixtures such as these is to attach back-up safety wires to them and anchor these wires to the floor or roof structure above, so that even if the ceiling grid distorts or collapses, the light fixture will not fall (Photo credit: EERI James L. Stratta).

Figure 5. Escape hole made through partition and view of jammed door. In the 1979 Imperial County, California Earthquake, the door to this office in the imperial county services building was jammed shut by the distortion of the structure. The occupant was trapped until co-workers broke through the sheet-rock clad metal stud partition wall (Photo credit: EERI, Christopher Arnold).

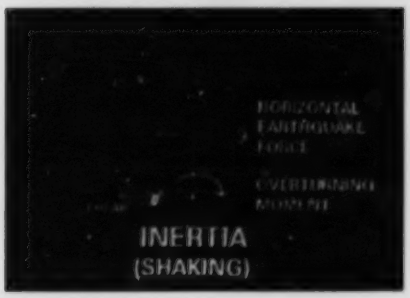


Figure 6. Diagram of shear and overturning. Inertial forces generated within unanchored nonstructural objects cause them to overturn if they are slender and to slide if they are stocky. This generalization is modified by the distribution of mass – some pieces of equipment are top-heavy and more prone to overturning under lateral loading than their proportions would indicate – and also by the amount of friction at the base – sliding is more likely as the friction decreases. Seismic codes specify seismic nonstructural component coefficients that are multiplied by the weight of the object to produce lateral design forces. Depending upon the applicable code or analysis method, factors are used in this calculation process to increase design forces for components that are especially hazardous or essential, located at an upper story level, or have flexible mountings rather than rigid bolted anchorage (Graphics credit: EERI, Federal Emergency Management Agency).

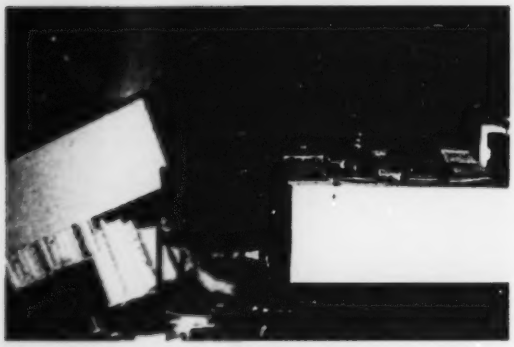


Figure 7. Overturned file cabinet. File cabinets are prone to overturning because of their slenderness, and they are even more vulnerable when unlatched drawers can slide out. This photo of the Santa Clara County Administration Building after the 1984 Morgan Hill Earthquake, shows that desks proportions make them unlikely to overturn and thus they provide good protection against nonstructural damage if occupants are trained to quickly take cover (Photo credit: EERI, Wesley Van Osdol).

Figure 8. Overturned file cabinet. The hazardous nonstructural damage pictured here occurred at coalinga district hospital in the 1993 Coalinga, California Earthquake (Photo credit: EERI, Sawant Rinal).

Figure 9. Overturned bookshelves. These library shelves in Seattle, Washington, overturned during the magnitude 7.1, 1949 Olympia Earthquake. Return to normal required not only reinstalling the shelves, but also sorting and shelving the books (Photo credit: Steinbrugge Collection, Earthquake Engineering Research Center, University of California, Berkeley, Harlan Edwards).

Figure 10. Spilled chemicals. Unrestrained chemicals can fall, their containers can break, and hazardous reactions can occur, even if the cabinetry itself is properly anchored, as shown here in an example from a high school's chemistry lab in the 1971 San Fernando Earthquake (Photo credit: EERI, Chuck Wilton).

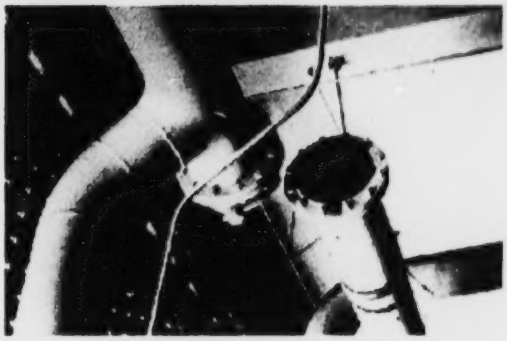


Figure 11. Broken pipe. Earthquake damage to piping is most frequently observed at joints. Although damage to small-diameter piping has been observed in recent earthquakes, lack of bracing on larger diameter piping typically makes them more seriously vulnerable. The damage here occurred in the 1971 San Fernando Earthquake at the original Olive View Hospital (Photo credit: EERI, J. Marx Ayres).

Figure 12. Water pouring down the stairs. Broken piping leads not only to direct property loss – the cost of repairing the piping – but is also often the cause of leakage and resulting water damage that is more costly to repair. The cascade of water down these stairs in an industrial building occurred in the 1971 San Fernando Earthquake (Photo credit, EERI, J. Marx Ayres).

DISTRICT NONSTRUCTURAL PROTECTION PROGRAM

Introduction

This section provides detailed information for school district staff on how to initiate and manage a School Nonstructural Earthquake Protection Program. Securing nonstructural elements to reduce earthquake-induced damage and injury may best be seen as part of the school district's responsibility to improve school safety. The program includes the identification of nonstructural earthquake hazards in school building spaces and the implementation of protection measures. Program issues related to necessary skills, safety, budgets, consistency, and liability generally require that Washington school district staff manage the nonstructural protection program. However, as proposed in this manual, building site teams with district support and training may be able to help meet district and school earthquake safety goals.

The large number of potential nonstructural earthquake hazards in any building makes the implementation of nonstructural earthquake protection measures a long-term, on-going task. District leadership will be needed to track and monitor program activities over time and to ensure that nonstructural protection measures are properly implemented.

Guiding principles

The assumptions and philosophies behind the School Nonstructural Earthquake Protection Program are:

- Strong earthquake ground shaking will damage nonstructural elements in school buildings.
- School buildings in western Washington are at greater risk of being damaged by an earthquake than those in eastern Washington. However, all Washington schools are exposed to earthquake hazards capable of damaging nonstructural elements of the building.
- Older, unreinforced masonry (brick) schools are the most vulnerable to earthquake-induced partial or total collapse, but all schools are likely to sustain damage to nonstructural elements.
- Elimination of all nonstructural earthquake hazards is not practical because costs may exceed the benefits and because some protective measures may interfere with necessary school operations.

Summary of program steps

The School Nonstructural Earthquake Protection Program may be established by completing these steps:

1. Define the school district's nonstructural protection program goals and identify program responsibilities. What does the district want to accomplish? Who will manage the district's program?
2. Obtain district support and commitment
3. Identify, coordinate, and manage the expertise that will be needed to complete program activities.
4. Train district maintenance, facilities, safety and security staff on how to use the information in this manual.
5. Complete the inventory of school building spaces for nonstructural earthquake hazards
6. Use the completed inventory forms to prepare a work plan. What Work Needs To Be Done?
7. Select and implement nonstructural earthquake protection measures using the details provided in Section C as a guide. How Will the Work Be Done?
8. Monitor and track all program activities.

Step One: Define the School District's Program Goals and Identify Potential Program Responsibilities

Program Goal: The primary goal of the School Nonstructural Earthquake Protection Program should be the safety of students, staff, teachers, and school visitors. Protection of school property and a return to normal school operations are important, but are generally secondary concerns.

Responsibilities: District staff will need to be involved in developing and overseeing program activities. District involvement is essential to maintaining a safe, reliable, and consistent program. Program activities may be integrated into existing facilities, maintenance, safety, and security programs. Nonstructural protection program responsibilities may include some or all of the following personnel and tasks:

- District maintenance staff will normally be responsible for developing the program goals and scope of activities. Other district staff and/or a district committee may help in this process. A consultant specializing in nonstructural earthquake protection programs may be hired to help outline the scope of the program.
- District maintenance staff may be responsible for training district staff in how to use this manual, how to inventory school building spaces, and how to implement nonstructural earthquake protection measures. A consultant specializing in nonstructural earthquake protection programs may be hired to help in the development and delivery of training.
- District maintenance staff could track work completed and monitor the implementation of nonstructural protection measures by district staff, equipment installers, contractors, and school site teams.
- District volunteer coordinator(s) will normally work with safety and security to identify potential school site team members, including school staff, parents, students, and community volunteers.
- District safety and security staff will normally have responsibility for training site team members, including school staff, parents, students, and community volunteers. District safety and security staff may help coordinate nonstructural program activities with district emergency response needs and priorities.
- School safety committees may coordinate the nonstructural program activities with school emergency response needs and priorities at the building level.
- School site teams may be responsible for inventorying and protecting selected nonstructural elements after receiving training from district staff. All school site team activities should be tracked and monitored by district staff and coordinated with school safety committees.

Step Two: Obtain District Management Support and Commitment

Support and commitment from district management will be necessary to implement the Nonstructural Earthquake Protection Plan consistently, systematically, and fairly in district school buildings. The district staff responsible for developing and overseeing the program should prepare a presentation for the District Budget Committee using the information in this manual to explain the following three elements:

- **Status:** What is the district's exposure to damaging earthquake activity? What are nonstructural earthquake hazards? How do these hazards threaten the staff, students, parents, and others working who may be studying, or visiting in school district buildings?
- **Target:** What is the level of protection that the district should establish for school building spaces?
- **Proposal:** How can the district achieve an acceptable level of protection? What activities and resources will be needed?

Step Three: Identify, Coordinate, And Manage the Expertise That Will Be Needed To Complete Program Activities

The large number and varying complexity of nonstructural elements in a school building call for an understanding of the type of training and expertise needed to:

- Identify and inventory potential nonstructural earthquake hazards.
- Select appropriate protective measures to reduce those hazards.
- Implement the selected measures.

Each school district will have staff with varying levels of engineering, architectural, and trade capability to perform the tasks called for to implement the different aspects of the nonstructural earthquake protection program.

District resources will normally determine which tasks will be carried out and by whom (see Financing). Tables 4a-4d list the advantages and challenges of the following four options for completing program tasks:

- **Option 1:** Use district staff
- **Option 2:** Use school site teams
- **Option 3:** Hire temporary district staff to be dedicated to the nonstructural program
- **Option 4:** Hire contractor(s)

Most districts will likely select a combination of the options presented above. Tables 4a-4d also include a list of tasks normally assigned for that option.

The services of a professional engineer may also be required to prepare appropriate construction drawings to guide the implementation of nonstructural earthquake protection measures for architectural, mechanical, and electrical systems and for heavy, expensive, or large furnishings and equipment. The construction drawings (details) included in Section C of this manual note when the services of a professional engineer may be needed. These details are provided to help district staff clarify the work that needs to be completed. Table 5 summarizes the nonstructural elements that may require the services of a professional engineer.

Table 4a
Option 1 — Use Regular District Staff To Manage the Nonstructural Earthquake Protection Program. Staff May Also Inventory Spaces and Implement These Protection Measures

Advantages	Challenges	Tasks Typically Assigned To District Staff
District staff are normally familiar with the construction, location of plumbing and wiring systems, and work that has already been completed in school district buildings. District staff can integrate the implementation of nonstructural protection measures with the completion of routine maintenance work orders, facility remodel work, and new construction design. District staff acquires capabilities during implementation of the program that enhance district skills and expertise. District staff is in a position to provide long-term, on-going oversight to foster consistent program implementation.	District staff time may already be committed to other projects. Other district priorities or emergencies may take staff away from the nonstructural earthquake protection program and delay completion of tasks. District staff may not have the specific skills needed to develop and manage all program activities. The services of a professional engineer may be required to design appropriate protection for more complex nonstructural elements.	■ Obtain district management support and commitment by making a presentation to the School Budget Committee on the need for a nonstructural protection program. ■ Define the program purpose and scope using the information provided in this manual. A consultant may be needed to help with this task. ■ Provide training to district maintenance staff, safety and security staff, and to School Site Teams. ■ Maintain records of work completed at each school. ■ Manage contracts with contractors, consultants, and engineers. ■ Inventory spaces with complex nonstructural elements or elements located in restricted areas. ■ Inspect work completed before and after earthquake shaking. ■ Recommend improvements to the manual. ■ Identify nonstructural elements to be addressed when designing new facilities, remodeling building spaces, and when selecting, purchasing, and installing new furnishings and equipment. ■ Develop nonstructural earthquake protection standards such as construction standards to guide engineers and architects in the design of nonstructural elements in new school buildings

Table 4b
Option 2 — Use The School Site Team To Complete A Building Inventory and Implement Nonstructural Earthquake Protection Measures

Advantages	Challenges	Tasks That Might Be Assigned To School Site Teams
School site teams can save the district money by reducing labor costs. School site teams may be especially motivated to try to improve the safety of the school in which team members work, have children enrolled, or visit on a regular basis. Community volunteers on the school site team may see safer schools as an integral part of improving community safety. School site teams may be especially successful in carrying out fund-raising activities when the money will be used to benefit the local neighborhood school. Funds can be used to cover expenses for school safety projects. School site teams can set a schedule for program activities that meet their particular concerns and priorities.	District resources will be needed to provide training and to manage school site team activities. District staff will need to track and monitor activities. School site teams may lack sufficient expertise to inventory all building spaces. Team expertise will vary from school to school. District staff and others will normally be needed to implement more complex nonstructural earthquake protection measures. Potential liability issues need to be carefully assessed when using non-district staff to complete work in spaces owned by the district. The district risk manager may suggest risk control measures to manage this potential liability. For example, team training should include safety topics such as the proper use of tools and equipment and how to prevent back injuries when moving heavy items. School site team members may be interested in only a small number of building spaces. District union representatives should be involved so as to prevent any conflicts with union requirements.	■ Complete program training. ■ Complete the inventory of nonstructural earthquake hazards in school building spaces according to team capabilities. ■ Prepare a request for self-help funding and assistance from the district to help complete program activities. ■ Carry out fund-raising activities to help complete program activities. ■ Maintain records of activities completed at the school and provide copies of records to district staff. ■ Implement nonstructural earthquake protection measures according to team capabilities. ■ Provide district staff with information to help improve manual guidance for other teams.

Table 4c
Option 3 — Hire Special District Staff To Complete Inventory And Implement Nonstructural Earthquake Protection Measures

Advantages	Challenges	Tasks That Might Be Assigned To Specialty District Staff
Hiring special district staff can accelerate the completion of program activities. If a large number of nonstructural elements are involved, a specialized district team may demonstrate cost savings over carrying out work in a piecemeal manner. Work will be carried out more consistently across the district if the same team is responsible. Specialized staff may be selected to complement existing staff and/or school site team capabilities. Temporary staff may be hired to add specialized skills to those of permanent district staff.	The normally heavy workload in most school districts will make it tempting to use the dedicated team for other projects. District hiring practice may not allow hiring temporary staff or staff that is dedicated to specific tasks. The district may still require the services of a professional engineer to design specialized nonstructural earthquake protection measures and to oversee implementation of design details. Implementation of some measures may require specific trade skills and permits. For example, a licensed contractor or plumber may be required.	■ Inventory building spaces or use inventories completed by school site teams. ■ Implement nonstructural earthquake protection measures according to methods outlined in the manual or prepared by engineers. ■ Provide district manager with records of actions completed and any problems encountered using manual details.

Table 4d
Option 4 — Hire Contractor(s) to Complete Inventory and Implement Nonstructural Earthquake Protection Measures.

Advantages	Challenges	Tasks Typically Completed By Contractors
The district can hire the expertise needed to complete specific tasks. If a large number of nonstructural elements must be addressed, there may be cost savings in hiring a contractor versus doing the work in a piecemeal manner. Hiring a contractor can limit district staff time to project management. Nonstructural protective measures may be added to existing contracts with some contractors. For example, remodel projects could also address nonstructural earthquake protection. Upgrades of sprinkler systems provide an opportunity to secure ceiling systems.	Hiring a contractor may be more costly than using district staff or school site teams. More specific construction details may be required in order to prepare bid specification documents. District staff may need to manage a number of contracts with various contract specialists in order to complete the work.	■ Implement nonstructural earthquake protection measures according to district staff specifications. ■ Address special nonstructural elements that require a particular type of expertise, training, or licensing.

Step Four: Train District Staff in How to Use the Information in This Manual

Training district staff in how to identify nonstructural earthquake hazards, how to inventory school spaces, how to implement nonstructural earthquake protection measures, and how to work with school site teams is an important part in the School Nonstructural Earthquake Protection Program. Trained staff will be more alert to potential nonstructural earthquake hazards in school building spaces and better able to incorporate earthquake safety into routine maintenance operations than untrained staff. Some districts may need to hire a consultant to assist with the development and delivery of staff training.

Step Five: Complete the Inventory of School Building Spaces

Use the inventory forms provided in Section B to collect data regarding nonstructural earthquake hazards located in school building spaces. These inventory forms will cover the nonstructural elements in five types of building spaces:

- **Special Use Areas**: These spaces, such as chemistry laboratories, kitchens, and automobile and wood shops, commonly have a number of nonstructural elements that may pose a high life safety hazard if damaged during earthquake shaking.
- **Assembly Occupancies**: Hallways, stairwells, and all-purpose rooms have the potential to expose many people at one time to potential earthquake hazards and they are critical to safely exiting the building.
- **Normal Occupancies**: Classrooms, offices, and libraries support the school's educational program. Suspended ceiling systems, storage cabinets, library shelving, and countertop equipment normally account for most of the nonstructural earthquake hazards in these spaces.
- **Utility And Mechanical Rooms**: These spaces contain the nonstructural elements that support the operation of water, electrical, and heating systems. Damage to these elements impact building operations rather than safety. However, damage to gas-fueled equipment may result in fire
- **Exterior Spaces**: Many school buildings have exterior features that have the potential of causing severe injuries if damaged during earthquake shaking. Many of these features are located over exits and other places where staff and students gather.

Grouping the inventory forms according to the type of building space helps to identify nonstructural elements unique to specific spaces, integrate the protection of nonstructural elements against earthquake damage with space remodels and other room-by-room inspections, and provides one approach for organizing school nonstructural earthquake hazard inventories. School site teams can use the inventory forms to focus on those spaces of special interest or concern to building occupants.

Either district staff or school site teams can inventory most nonstructural elements located in these five types of building spaces after completing a district training class. However, some elements may require special inventory skills or the elements may be located in spaces that are not easily accessible to the school site teams. District staff may want to take the responsibility for completing inventories in spaces that are generally locked, such as utility and mechanical rooms, penthouses, and rooftops. District staff may also want to take the responsibility for hiring consultants to inventory more complex nonstructural elements, such as architectural elements.

The inventory forms are duplicated and included in a separate "Action Packet". This packet makes copying inventory forms easier, prevents damage to the manual, and enables district staff to add information pertaining to their specific school district or program. Copies of blank inventory forms can be made for each of the spaces to be inventoried. A copy of the completed inventory form should be sent to the district program manager and a copy should be maintained by the school site team.

When completing the nonstructural earthquake hazards inventory, persons inventorying will need the following:

- A copy of the inventory form from the Action Pack for the space or spaces you will be inventorying.
- Clipboard
- Pen or pencil
- Flashlight
- Tape measure
- Room keys
- Camera
- Step ladder
- Video camera (optional)

Step Six: Use Completed Inventory Forms To Prepare A Work Plan

District staff may review the completed inventory forms and use Tables 4a-4d and 5 to determine which elements will be addressed in the nonstructural program and by whom. Work may be organized into the following categories:

- School site safety teams
- District maintenance staff
- Contractors
- Engineering services

Supplies will be provided to the school site teams for completing each nonstructural protection measure shown on the construction drawings (details), located in Section C of this manual. The school site team work plan needs to focus on what work will be done, where, by whom, and when. School site teams can use the work plan to develop a self-help proposal to submit to the district to obtain support.

Work plans for nonstructural protection measures that require district staff, contractors, or professional engineering services, need to consider a number of factors when estimating project costs:

- Who will do the work? Will all inventory and implementation work be completed by district staff? Will the volunteer school site teams help complete some tasks? How many elements will be done at one time?
- Is professional engineering design required?
- What performance goal is to be applied?
- Will work require relocation of building occupants?
- Can the implementation of nonstructural earthquake protection measures be combined with other building projects?

Step Seven: Identify and Select Nonstructural Earthquake Protection Measures

Nonstructural earthquake protection details are provided in Section C of this manual following the inventory forms. The services of a professional engineer may be required to develop construction drawings for some elements. "Engineering required" is marked on these details. These details are provided in this manual to give a general idea of the work that needs to be done. Table 5 lists the elements that normally require the services of a professional engineer to prepare an appropriate earthquake protection design. Table 5 also lists the type of skills required to install the protective measure according to the engineer's design.

A shopping list of materials and equipment required to complete earthquake protection measures appropriate for the school site teams is provided on each detail.

Step Eight: Monitor and Track All Program Activities

Proper maintenance of nonstructural plan records will enable the district manager to better plan and coordinate district and school site team activities. Each inventory form should contain:

- The date the inventory was completed.
- The spaces that were inventoried.

- A measure of the number of nonstructural elements that need to be protected.
- The date that the nonstructural earthquake protection measure was installed.
- The cost to carry out the nonstructural earthquake protection measure.
- The date that a copy of the inventory form was sent to the school district manager.
- The skill that was needed to implement the selected measure.

Table 5
Nonstructural Elements For Which Engineering Services May Be Required To Design Appropriate Earthquake Protection Measures

Nonstructural Category	Nonstructural Elements	Design Implementors
■ Mechanical systems	■ Boilers ■ Water tanks ■ Condensate tanks ■ Flue pipes ■ Breechings ■ Compressors ■ Fan-coil units ■ Heat exchangers and heat pumps ■ Elevators	■ District maintenance staff ■ Contractors ■ Plumbers *Note: A plumbing permit may be required for some tasks.*
■ Electrical system	■ Site transformer ■ Uninterrupted power system ■ Wire distribution system ■ Emergency power system	■ Service Provider ■ Maintenance Staff ■ Contractor *Note: An electrical permit may be required for some tasks.*
■ Architectural elements – exterior	■ Masonry chimneys ■ Covered play areas ■ Canopies ■ Parapets ■ Cornices ■ Cap-Stones ■ Cladding	■ Contractor
■ Architectural elements – interior	■ Walls acting as supports for heavy shelves or equipment ■ Special light fixtures	■ Contractor
■ Furnishings and equipment	■ Equipment on vibration mounts ■ Unusually large and/or tall equipment ■ Heavy, wall-mounted shelving systems ■ Tall, heavy racking systems ■ Sensitive laboratory equipment ■ Equipment located above the third floor	■ District maintenance staff ■ Contractor

Financing

The option(s) selected in Step Three for managing and implementing a nonstructural protection program will depend to some extent upon the source and availability of financing. Public financing may have specific requirements for the type and training of personnel and the level of documentation required to identify and correct nonstructural earthquake hazards. Private financing may focus on specific elements or areas of interest to the donor. This section identifies some financing sources that might be available to support a nonstructural protection program.

School districts in Washington State may obtain funds for financing capital improvements from some or all of the following sources (see the OSPI School Facilities Manual for details):

- Sale of general obligation bonds authorized for school building construction purposes and currently collectible.
- Voter-authorized excess tax levies for capital purposes.
- Proceeds from investments of capital project fund moneys.
- Funds received from the state for assistance in the construction of school facilities
- Funds received from other sources (federal funds, insurance proceeds, property sales, etc.) and available for the construction of school facilities.
- Mitigation fees from environmental impacts by the State Environmental Protection Act (SEPA). SEPA mitigation fees are not part of local matching for school construction.
- Impact fees or charges for expanding school facilities to meet growth under the Growth Management Act (GMA). GMA impact fees are part of local funding for school construction. Refer to Growth Impact Fees WAC 180-27-032.

Some districts may be able to obtain funds for reducing nonstructural earthquake hazards from

- Federal or state hazard mitigation grants, such as the FEMA initiated Seattle Project Impact partnership that funded the revision of this manual and the implementation of nonstructural mitigation measures in Seattle School buildings.
- Private sector community partners, such as insurance companies, banks, local radio or television stations, or any of many private companies concerned about the safety of school children.
- School site teams may donate time and resources to address nonstructural earthquake hazards at their schools.
- Volunteer organizations like the American Red Cross, Habitat for Humanity, Christmas in April, and National Voluntary Organizations Active is Disaster may donate supplies or assist in implementation of nonstructural mitigation details.

SCHOOL SITE TEAMS

Introduction

School Site Teams can be a key part of a district nonstructural protection program. These teams may consist of teachers, parents, non-profit volunteer organizations, and other volunteers interested in helping improve school safety. The School Safety Committee may provide a nucleus for forming and overseeing activities of Site Teams.

Site teams can coordinate with district personnel in the completion of inventories of nonstructural elements in school building spaces. The extent of the team's participation in the inventory will depend upon the skills, training, and interests of the site team.

Site teams can implement some nonstructural protection measures. Table 6 shows tasks generally suitable for school Site Teams. Ideally, district staff will provide centralized coordination and management of nonstructural earthquake protection activities.

Initiation

Site Teams may be encouraged by the district or initiated by interested staff, parents, or students at the building level. Ideas for initiating a Site Team include:

- Develop a short presentation on the need to establish a nonstructural protection plan using the material in the guide.
- Deliver the presentation to the building administrator, Safety Committee, or other district group with the authority to support your program.
- Call districts in areas that have sustained earthquake damage to identify specific impacts on comparable school facilities.
- Use newspaper reports showing damage to schools.
- Identify school site team volunteers.
- Seek out training on nonstructural protection activities.
- Identify support needed by school site teams, including workspace, tools, and repair supply lists (Section C).
- Identify potential funding sources, including community partners.
- Package supplies individually for selected nonstructural elements to make implementation easier. For example, package the materials for securing desktop equipment.
- Consider storage location of nonstructural protection products and tools. The Seattle School District will be placing a storage container at each school site. Mitigation and preparedness materials will be stored inside.

Summary of site team activities

The Site Team should follow a process similar to the districts, but tailored to meet the interests and capabilities at the building level:

1. Define the building level nonstructural protection goals and objectives that the Site Team wants to accomplish. These may be more or less detailed than the district's goals. Generally the Site Team will focus on protecting nonstructural elements that do not require engineering or other building expertise to identify and implement.
2. Obtain support and commitment of the building administrator. Access to school spaces may require coordination with school custodial or maintenance staff.
3. Find out if there is a district nonstructural protection program that will provide training, supplies, guidance, etc.
4. Identify, coordinate, and manage the expertise that will be needed to complete program activities.
5. Request training from the district on how to use the information in this manual.
6. Complete the inventory of school building spaces for nonstructural earthquake hazards. The team may want to inventory all spaces, selected spaces, or implement mitigation of selected elements without completing an inventory.

7. Use the completed inventory forms to prepare a work plan (What Work Needs To Be Done?) Or list number and type of desktop equipment to be secured.
8. Select and implement nonstructural earthquake protection measures using the details provided in Section C as a guide. (How Will the Work Be Done?) If using pre-packaged kits, follow kit instructions.
9. Monitor and track all program activities.

Inventory Tools
When completing the nonstructural earthquake hazards inventory, persons inventorying will need the following:

- A copy of the inventory form from the Action Pack for the space or spaces you will be inventorying
- Clipboard
- Pen or pencil
- Flashlight
- Tape measure
- Room keys
- Camera
- Video camera (optional)
- Step ladder

Training

Participating school site teams should receive training on:

- Information on local earthquake hazards
- What causes nonstructural earthquake hazards.
- How to identify potential nonstructural earthquake hazards.
- How to fill out the inventory forms in Section B of this guide.
- How to prepare a work plan.
- What tools and materials are needed to complete the inventory and to correctly implement the nonstructural earthquake protection methods.
- Safe practices for completing an inventory of school building spaces, using tools, and moving and relocating furnishings and equipment.
- Record keeping tracking the completion of tasks.

Management

- Maintain school site team inventory data sheets.
- Monitor activities by recording activities completed and keeping records up-to-date. If there is a district program be sure to copy records to the district nonstructural protection manager.
- Remember to recognize and reward school Site Team volunteers to show appreciation for their activities.

Table 6
School Site Team Tasks
Nonstructural Earthquake Protection Tasks Suitable for School Site Teams

Task	Action
Inventory	Identify potential nonstructural earthquake hazards. Most site teams will focus on identifying nonstructural earthquake hazards in Normal Occupancy areas like classrooms, libraries, and offices.
Data management	Maintain school site inventory records. Send copies of records of work completed to district manager.
Implementation of nonstructural earthquake protection measures	Secure desktop and counter-top equipment, such as computers, aquariums, and microwaves, weighing less than 40 pounds. Secure lightweight, overhead elements weighing less than 25 pounds (hanging plants, mobiles, and shelf contents) to ceiling structure. Secure equipment on audio-visual carts to the cart; tether the cart to the wall when not in use. Install shelf restraints to prevent hazardous materials, such as chemicals in science laboratories, from falling to the floor and breaking their containers. Make sure chemicals are labeled and stored appropriately. Locate bookshelves, storage cabinets, coat closets, and file cabinets in low occupancy areas if possible.
	The following elements may require district assistance. Secure classroom bookshelves, storage cabinets, and coat closets more than 48 inches tall to the wall studs. The services of a professional engineer may be required to evaluate the capacity of the wall to support heavier shelves and cabinets. Secure objects, such as wall cabinets, pictures, televisions, and fire extinguishers weighing less than 50 pounds to the wall studs. Care should be given to the potential that electrical conduit may be present inside wall spaces. Secure floor-mounted equipment, such as drill presses, to the floor. Verify with district staff that floor is not made of prestressed concrete, which could be structurally damaged by installation of bolts. District staff or contractors should normally secure floor-mounted equipment over 250 pounds or containing electrical systems, such as transformers.
Preparation of information sheets on reducing nonstructural earthquake hazards in the home	Prepare information sheets on protecting nonstructural elements in the home using the information in this Guide. Provide assistance in identifying potential home nonstructural earthquake hazards and implementing home nonstructural earthquake protection measures.

SCHOOL FACILITIES MANUAL
Nonstructural Protection Guide

SECTION B

INVENTORY FORMS AND INVENTORY PROCESS FOR NONSTRUCTURAL ELEMENTS

INVENTORY FORMS FOR NONSTRUCTURAL ELEMENTS

This section can be duplicated and provided for inclusion in a separate Training Packet. This will enable the inventory forms to be copied more easily, keep the manual intact, and enable school districts to tailor the Training Packet to meet district specific needs and requirements.

Inventory Actions

- Determine the level of detail for your inventory. Do you want to inventory all spaces, selected spaces, or selected elements?
- Identify the skills you will need to complete your inventory.
- Select and copy the inventory form(s) needed to cover each area to be included in your inventory from the forms provided in the Training Packet.
- Prepare an Inventory Record binder to maintain a record of all inventory work completed. This binder may be kept in the school office and maintained by a designated member of the School Safety Committee.
- Enter the information on the top of each inventory form that you will be using.
- Collect the tools needed to complete the inventory. Review the information in the District and School Site Team sections for suggestions.
- Complete the inventory.
- File the inventory in the Inventory Record binder.
- Select elements that your team wants to correct from the inventory.
- Prepare a brief form identifying the location, elements to be corrected, and details to be used.
- Copy the list and the inventory and send to the District Nonstructural Protection Program manager.
- Lists may be prepared by maintenance, custodial, or building Site Teams. Coordination of activities is needed to prevent duplication of effort.

Quick Protection Actions

You may want to carry out a number of selected actions to improve site safety without completing a formal inventory. The actions below focus on a limited number of elements generally found in classrooms that do not require special expertise to identify or correct. These actions should become standard classroom practice to avoid creating new earthquake hazards. The following are suggested Quick Protective Actions:

- Store heavy items on lower shelves. It is important that building occupants maintain an awareness of the need to prevent heavy items from crashing down on people and equipment.
- Secure hanging plants or other hanging displays using closed rather than open hooks.
- Place tall file cabinets and shelving (more than 4 feet) in low occupancy areas, such as closets. Be careful about moving any heavy furniture. You should understand how to prevent back injuries. You may need to have custodial or maintenance staff do this task for you.
- Secure desktop equipment and displays that could injure room occupants, such as computers, printers, typewriters for which a relatively easy correction can be implemented. For example, your school can identify the typical size and weight of computers and have a vendor prepare kits to secure those elements.
- Consider a simple form to identify actions that have been completed to include in the Inventory Record binder.

1. Normal Occupancies: Classrooms, Offices, And Library Spaces

School Name:_____ **Classroom # Or Name Of Space Inventoried:**_____ **Inventory Date:**_____ **Inventory By (Name):**_____ **Date Copy Sent To District:**_____	**Check If Nonstructural Element Is Not Present**	**Check If Condition Ok**	**Check If Condition Needs Correcting**	**Enter Quantity**	**Enter Date Condition Corrected (MM/DD/YY)**	**Enter Nonstructural Detail Number Used In Repair**
Overhead Elements						
Suspended ceilings are braced with a minimum of four diagonal wires attached to the structure above at a spacing of no more than 12 feet (Detail 10.1, 10.2, and 10.3).				Estimate area of ceiling in square feet:	__/__/__	
Suspended ceiling is separated from enclosing structural walls at the edges by a minimum of ½ inch (Detail 10.1).				Estimate circumference of ceiling in feet:	__/__/__	
Lay-in tiles used in ceiling panels at exit ways and in corridors are secured with clips (Detail 10.1).				Enter number of tiles:	__/__/__	
Suspended ceiling is not used to laterally support the tops of gypsum board or masonry partitions (Detail 11.1).				Enter length of support in feet:	__/__/__	
Suspended light fixtures, air diffusers, and ventilation grills are supported and braced independently of the suspended ceiling system. Ventilation grills are secured with safety wire (Detail 10.4).				Enter number of lights and grills:	__/__/__	
Pendant-mounted lights or double-hung fluorescent lights are secured with safety wire to ceiling joist (Detail 10.5).				Enter number of light fixtures:	__/__/__	

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School Name:_____ Classroom # Or Name Of Space Inventoried:_____ Inventory Date:_____ Inventory By (Name):_____ Date Copy Sent To District:_____	Check If Nonstructural Element Is Not Present	Check If Condition Ok	Check If Condition Needs Correcting	Enter Quantity	Enter Date Condition Corrected (MM/DD/YY)	Enter Nonstructural Detail Number Used In Repair
Heavy hanging planters or other decorative objects are secured with safety wire to ceiling joist or placed on low surface.				Enter number of hanging objects:	__/__/__	
Wall Elements						
Ceiling-height partition walls that extend to the suspended ceiling grid are braced to the structure above, particularly if they support wall-mounted furnishings (Detail 11.1).				Enter length of each wall in feet:	__/__/__	
Masonry partition walls are braced to the structure above (Detail 11.2). These walls should be removed if possible.				Enter length of each wall in feet:	__/__/__	
Lockers and cabinets are anchored to a wall stud or into a concrete wall (Detail 6.4).				Enter number of lockers or cabinets:	__/__/__	
Wall-mounted objects weighing more than 50 pounds - maps, projection screens, artwork, fire extinguishers, television sets, clock, etc. - are anchored to a wall stud or if less than 50 pounds to the wall board (Detail 6.9).				Enter number of objects:	__/__/__	
Shelving units and free-standing coat closets are anchored to the floor and to a wall stud; shelves are attached to the unit frame, and backs of shelving units are braced; overhead struts connect units (Detail 6.7).				Enter number of shelving units or closets:	__/__/__	

School Name:_____ **Classroom # Or Name Of Space Inventoried:**_____ **Inventory Date:**_____ **Inventory By (Name):**_____ **Date Copy Sent To District:**_____	**Check If Nonstructural Element Is Not Present**	**Check If Condition Ok**	**Check If Condition Needs Correcting**	**Enter Quantity**	**Enter Date Condition Corrected (MM/DD/YY)**	**Enter Nonstructural Detail Number Used In Repair**
Shelf contents have shelf-lips or other shelf restraints high enough to prevent tall objects from overturning onto the floor, positively latched cabinet doors, or other restraints. Heavy items are stored low (Detail 6.6).				Enter total linear feet of shelving:	__/__/__	
Glass panels, windows, or other panes of glass are made of safety glass or protected from breaking (Detail 7.1).				Enter the size of each glass pane in square feet:	__/__/__	
Desk-Top and Counter-Top Equipment						
Desktop and counter-top equipment, like personal computers, are restrained by friction pads, leash locks, bungee cords, or other methods (Detail 6.1).				Enter the number of pieces of equipment:	__/__/__	
Interior wires are protected from falling nonstructural elements. Adequate slack is provided where wires are connected to equipment, where they extend through openings in a wall, and where they cross seismic joints (Detail 3.4).				Enter number of connections that need to have slack installed:	__/__/__	
Aquariums, heavy potted plants, and other heavy objects are secured or stored low (Details 6.1).				Enter number of objects:	__/__/__	

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School Name:_____ Classroom # Or Name Of Space Inventoried:_____ Inventory Date:_____ Inventory By (Name):_____ Date Copy Sent To District:_____	Check If Nonstructural Element Is Not Present	Check If Condition Ok	Check If Condition Needs Correcting	Enter Quantity	Enter Date Condition Corrected (MM/DD/YY)	Enter Nonstructural Detail Number Used In Repair
Furnishings and Equipment, Free Standing						
File cabinets 4 feet or taller are anchored to the floor or to a wall stud (Detail 6.2) or are located in low-occupancy areas away from hallways, exits, and student desks.				Enter number of file cabinets:	__/__/__	
File cabinets arranged in groups are attached to one another (Detail 6.2).				Enter number in each group and number of groups:	__/__/__	
File cabinet drawers have latches (Detail 6.2).				Enter number of drawers:	__/__/__	
Tall, narrow, heavy freestanding objects like card catalogs are anchored to the floor or to a wall stud (Detail 6.3).				Enter number of objects:	__/__/__	
Wheel-mounted furniture is equipped with wheel locks or tethers; objects on top of wheel-mounted furniture (like audio-visual carts) are strapped on (Detail 6.10).				Enter number of pieces of furniture: Enter number of objects on top:	__/__/__	

School Name:_____ Classroom # Or Name Of Space Inventoried:_____ Inventory Date:_____ Inventory By (Name):_____ Date Copy Sent To District:_____	Check If Nonstructural Element Is Not Present	Check If Condition Ok	Check If Condition Needs Correcting	Enter Quantity	Enter Date Condition Corrected (MM/DD/YY)	Enter Nonstructural Detail Number Used In Repair
Modular partition walls are arranged in zigzag or tee-shaped fashion. Single modular partitions are anchored to the floor (Detail 11.3). Use lightweight modular partition walls instead of file cabinets to divide classroom into work areas.				Enter length of walls in feet:	__/__/__	

Emergency Supplies, Equipment, And Information

Yes	No	
		There are sufficient emergency supplies for each member in the classroom, office, or library (first aid supplies, water, space blankets, battery-operated radio, food, flashlight, or candlesticks).
		A list of student names and home emergency contact information (name of emergency contact and telephone number) is kept current for each classroom. Consider adding this information to student identification cards.
		A list of staff names and home emergency contact information (name of emergency contact and telephone number) is kept current, including main office staff, school nurse, etc.)
		School emergency procedures are posted in each classroom, office, and library.

2. Assembly Occupancies: Multi-Purpose Rooms, Halls, Stairwells, Exits, Gymnasiums, And Auditoriums

School Name:_____ **Classroom # or Name of Space Inventoried:**_____ **Inventory Date:**_____ **Inventory By (Name):**_____ **Date Copy Sent to District:**_____	**Check if nonstructural element is NOT present**	**Check if condition is OK**	**Check if condition needs correcting**	**Enter quantity of each nonstructural element to be corrected**	**Enter date condition was corrected**	**Enter nonstructural detail number used in repair**
Overhead Elements						
Skylight glass panels are made of safety glass or protected from breaking (Detail 7.1).				Enter number of skylights:	__/__/__	
Suspended ceilings are braced with a minimum of four diagonal wires attached to the structure above at a spacing of no more than 12 feet (Details 10.1, 10.2, and 10.3).				Estimate area of ceiling in square feet:	__/__/__	
Suspended ceiling is separated from enclosing structural walls at the edges by a minimum of 1/2-inch (Detail 10.1).				Estimate circumference of ceiling in feet:	__/__/__	
Lay-in tiles used in ceiling panels in hallways and at exits are secured with clips (Detail 10.1).				Enter number of tiles:	__/__/__	
Suspended ceiling is not used to laterally support the tops of gypsum board or masonry partition walls (Detail 11.1).				Enter length of wall supported in feet:	__/__/__	
Suspended light fixtures, air diffusers, and ventilation grills are supported and braced independently of the suspended ceiling system. Ventilation grills are secured with safety wire (Detail 10.4).				Enter number of lights and grills:	__/__/__	

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School Name:_____ **Classroom # or Name of Space Inventoried:**_____ **Inventory Date:**_____ **Inventory By (Name):**_____ **Date Copy Sent to District:**_____	**Check if nonstructural element is NOT present**	**Check if condition is OK**	**Check if condition needs correcting**	**Enter quantity of each nonstructural element to be corrected**	**Enter date condition was corrected**	**Enter nonstructural detail number used in repair**
Pendant-mounted lights or double-hung fluorescent lights are secured with safety wire to ceiling joist (Detail 10.5).				Enter number of light fixtures:	__/__/__	
Heavy hanging planters or other decorative objects are secured with safety wire to ceiling joist or placed on low surface.				Enter number of hanging objects:	__/__/__	
Cable tray supports are braced (Detail 3.1).				Enter length of cable tray in feet:	__/__/__	
Suspended piping is braced to wall stud and anchored to ceiling structure (Detail 9.6).				Enter length of piping in feet:	__/__/__	
Suspended space heaters are anchored to ceiling structure and unit legs are braced (Detail 10.7).				Enter number of heaters:	__/__/__	
Wall Elements						
Stairways are enclosed by walls made of non-brittle materials. No walls use brittle materials (hollow clay tile, glass block or unreinforced masonry) to enclose stairways. "Gang plan" details allow stair landings to slide (especially in flexible buildings). Stairways are equipped with emergency lighting (Detail 4.3).				Enter the length and width of each wall in feet: Enter number of landings:	__/__/__	

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School Name:_____ **Classroom # or Name of Space Inventoried:**_____ **Inventory Date:**_____ **Inventory By (Name):**_____ **Date Copy Sent to District:**_____	**Check if nonstructural element is NOT present**	**Check if condition is OK**	**Check if condition needs correcting**	**Enter quantity of each nonstructural element to be corrected**	**Enter date condition was corrected**	**Enter nonstructural detail number used in repair**
Doors to hallways are secured with positive latches and equipped with automatic door closers. Doorways are clear of objects that may block them during an earthquake (Detail 4.2).				Enter number of doors:	__/__/__	
Ceiling-height partition walls that extend to the suspended ceiling grid are braced to the structure above, particularly if they support wall-mounted furnishings (Detail 11.1).				Enter length of each wall in feet:	__/__/__	
Masonry partition walls are braced to the structure above (Detail 11.2). These walls should be removed if possible.				Enter length of each wall in feet:	__/__/__	
Folding wall dividers are secured to prevent collapse onto room occupants.				Enter length and height of wall:	__/__/__	
Lockers, cabinets, display cases, and coat closets are anchored to a wall stud or into a concrete wall (Details 6.4; 6.7).				Enter number of units:	__/__/__	
Wall-mounted objects - fire extinguishers, television sets, clock, emergency lights, etc., weighing more than 50 pounds are anchored to a wall stud or, if less than 50 pounds, to the wall board is acceptable (Detail 6.9).				Enter number of wall objects:	__/__/__	
Display case glass, windows in doors, or other panes of glass are made of safety glass or protected from breaking (Detail 7.1).				Enter the size of each glass pane in feet:	__/__/__	

School Name:_____ **Classroom # or Name of Space Inventoried:**_____ **Inventory Date:**_____ **Inventory By (Name):**_____ **Date Copy Sent to District:**_____	**Check if nonstructural element is NOT present**	**Check if condition is OK**	**Check if condition needs correcting**	**Enter quantity of each nonstructural element to be corrected**	**Enter date condition was corrected**	**Enter nonstructural detail number used in repair**
Gym apparatus is anchored to a wall stud (Detail 6.8; 6.9)				Enter number of units:	__/__/__	

Furnishings and Equipment, Free Standing						
Vending machines, refrigerators, and freezers are anchored to the floor and adjacent walls (Details 6.5, 6.8).				Enter number of units:	__/__/__	
Heavy wheel-mounted equipment like pianos and folding bleachers have wheel locks or are tethered to a wall stud. (Detail 6.10)				Enter number of units:	__/__/__	

Yes	**No**	
		Building floor plans with exit routes are posted to clearly indicate how to safely evaluate the building.
		School district staff have updated building floor plans.
		Public address system is connected to emergency power.
		Exits are clearly marked.
		Capability exists to provide on-site shelter in high occupancy assembly areas.

3. Special Use Occupancies: Kitchens, Shops, Art Rooms, Science And Computer Laboratories, And Pool Rooms

School Name:_____ Classroom # or Name of Space Inventoried:_____ Inventory Date:_____ Inventory By (Name):_____ Date Copy Sent to District:_____	Check If Nonstructural Element Is NOT Present	Check If Condition OK	Check If Condition Needs Correcting	Enter Quantity Of Each Nonstructural Element To Be Corrected	Enter Date Condition Was Corrected (MM/DD/YY)	Enter Nonstructural Detail Number Used In Repair
Overhead Elements						
Suspended ceilings are braced with a minimum of four diagonal wires attached to the structure above at a spacing of no more than 12 feet (Details 10.1; 10.2; and 10.3).				Estimate area of ceiling in square feet:	__/__/__	
Suspended ceiling is separated from enclosing structural walls at the edges by a minimum of ½ inch (Detail 10.1).				Estimate circumference of ceiling in feet:	__/__/__	
Lay-in tiles used in ceiling panels at exit ways and in corridors are secured with clips (Detail 10.1).				Enter number of tiles:	__/__/__	
Suspended ceiling is not used to laterally support the tops of gypsum board or masonry partitions (Detail 11.1).				Enter length of wall supported in feet:	__/__/__	
Suspended light fixtures, air diffusers, and ventilation grills are supported and braced independently of the suspended ceiling system. Ventilation grills are secured with safety wire (Detail 10.4).				Enter number of lights and grills:	__/__/__	

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School Name:_____ **Classroom # or Name of Space Inventoried:**_____ **Inventory Date:**_____ **Inventory By (Name):**_____ **Date Copy Sent to District:**_____	**Check If Nonstructural Element Is NOT Present**	**Check If Condition OK**	**Check If Condition Needs Correcting**	**Enter Quantity Of Each Nonstructural Element To Be Corrected**	**Enter Date Condition Was Corrected (MM/DD/YY)**	**Enter Nonstructural Detail Number Used In Repair**
Pendant-mounted lights or double-hung fluorescent lights are secured with safety wire to ceiling joist (Detail 10.5).				Enter number of light fixtures:	__/__/__	
Heavy hanging planters or other decorative objects are secured with safety wire to ceiling joist or placed on low surface.				Enter number of hanging objects:	__/__/__	
Suspended air conditioning units are anchored to ceiling structure and unit legs are braced (Detail 9.5).				Enter number of units:	__/__/__	
Suspended space heaters are anchored to ceiling structure and unit legs are braced (Detail 10.7).				Enter number of units:	__/__/__	
Wall Elements						
Ceiling-height partition walls that extend to the suspended ceiling grid are braced to the structure above, particularly if they support wall-mounted furnishings (Detail 11.1).				Enter length of each wall in feet:	__/__/__	
Masonry partition walls are braced to the structure above (Detail 11.2). These walls should be removed if possible.				Enter length of each wall in feet:	__/__/__	
Lockers and cabinets are anchored to a wall stud or into a concrete wall (Detail 6.4).				Enter number of lockers or cabinets	__/__/__	

School Name:_____ **Classroom # or Name of Space Inventoried:**_____ **Inventory Date:**_____ **Inventory By (Name):**_____ **Date Copy Sent to District:**_____	**Check If Nonstructural Element Is NOT Present**	**Check If Condition OK**	**Check If Condition Needs Correcting**	**Enter Quantify Of Each Nonstructural Element To Be Corrected**	**Enter Date Condition Was Corrected (MM/DD/YY)**	**Enter Nonstructural Detail Number Used In Repair**
Wall-mounted objects - maps, projection screens, artwork, fire extinguishers, television sets, clock, etc. weighing more than 50 pounds are anchored to a wall stud or if less than 50 pounds to the wall board (Detail 6.9).				Enter number of objects:	__/__/__	
Shelving units and free-standing coat closets are anchored to the floor and to a wall stud; shelves are attached to the unit frame, and backs of shelving units are braced; overhead struts connect units (Detail 6.7).				Enter number of shelving units or closets:	__/__/__	
Shelf contents have shelf-lips or other shelf restraints high enough to prevent tall objects from overturning onto the floor, positively latched cabinet doors, or other restraints. Heavy items are stored low (Detail 6.6).				Enter total linear feet of shelving:	__/__/__	
Hazardous material stored on shelves is restrained, fragile containers protected, and containers organized to prevent mixing of reactive contents (Detail 8.1).				Enter length of shelving in feet:	__/__/__	
Glass panels, windows, or other panes of glass are made of safety glass or protected from breaking (Detail 7.1).				Enter the size of each glass pane in square feet:	__/__/__	
Counter-Top Equipment						
Counter-top equipment (like personal computers, ice machines, microwaves, and small drill presses) are restrained by friction pads, leash locks, bungee cords, or other appropriate method (Detail 6.1).				Enter the number of pieces of equipment:	__/__/__	

School Name:_____ **Classroom # or Name of Space Inventoried:**_____ **Inventory Date:**_____ **Inventory By (Name):**_____ **Date Copy Sent to District:**_____	**Check If Nonstructural Element Is NOT Present**	**Check If Condition OK**	**Check If Condition Needs Correcting**	**Enter Quantity Of Each Nonstructural Element To Be Corrected**	**Enter Date Condition Was Corrected (MM/DD/YY)**	**Enter Nonstructural Detail Number Used In Repair**
Interior wires are protected from falling nonstructural elements. Adequate slack is provided where wires are connected to equipment, where they extend through openings in a wall, and where there they cross seismic joints (Detail 3.4).				Enter number of connections that need to have slack installed:	__/__/__	
Aquariums, heavy potted plants, and other heavy objects are secured or stored low (Detail 6.1).				Enter number of objects:	__/__/__	
Furnishings and Equipment, Free Standing						
Pool filtration tanks are anchored to the structure or foundation (Detail 9.1).				Enter number of units:	__/__/__	
Compressed gas cylinders are restrained (Detail 8.2).				Enter number of cylinders:	__/__/__	
Water heaters are anchored to the floor and to a wall stud (Detail 9.7).				Enter number of water heaters:	__/__/__	
Shop equipment (table saws, drill presses, etc.) is anchored to the floor (Detail 6.1).				Enter number of units:	__/__/__	

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School Name:_____ **Classroom # or Name of Space Inventoried:**_____ **Inventory Date:**_____ **Inventory By (Name):**_____ **Date Copy Sent to District:**_____	**Check If Nonstructural Element Is NOT Present**	**Check If Condition OK**	**Check If Condition Needs Correcting**	**Enter Quantity Of Each Nonstructural Element To Be Corrected**	**Enter Date Condition Was Corrected (MM/DD/YY)**	**Enter Nonstructural Detail Number Used In Repair**
File cabinets arranged in groups are attached to one another (Detail 6.2).				Enter number of units:	__/__/__	
Ovens are anchored or tethered to the floor and flexible gas pipe connections installed.					__/__/__	
Refrigerators, freezers, and vending machines (Detail 6.5; 6.8).					__/__/__	
Fume hoods are secured to lab bench.				Enter number of units:	__/__/__	
Raised access floors in computer rooms, labs, and music rooms are braced when floor height exceeds 12 inches. Access floor supports are anchored to the floor (Detail 2.1).				Enter floor dimensions in square feet: Enter number of supports:	__/__/__	
Wheel-mounted equipment has wheel locks or is tethered (Detail 6.10).				Enter number of units:	__/__/__	

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Emergency Supplies, Equipment, and Information

Yes	No	
		Automatic gas or electricity shut-off(s) are installed on shop and laboratory equipment.
		Manual gas and electricity shut-off information is posted and keys are available.
		Staff and students are trained to move away from dangerous areas during ground shaking.
		Spill control and/or clean-up materials are kept in science laboratories, poolrooms, and other areas where hazardous materials are stored.
		Area specific emergency procedures are posted.
		.An updated inventory is maintained of all chemicals on site.
		Telephone number of nearest burn center is posted.
		Material Supply Data (MSD) inventory of chemicals are posted.

Comments

4. Support Occupancies: Utility Rooms, Mechanical Rooms, Storage Rooms And Penthouses

School Name:_____ Classroom # or Name of Space Inventoried:_____ Inventory Date:_____ Inventory By (Name):_____ Date Copy Sent to District:_____	Check If Nonstructural Element Is NOT Present	Check If Condition Is OK	Check If Condition Needs Correcting	Enter Quantity Of Each Nonstructural Element To Be Corrected	Enter Date Condition Was Corrected (MM/DD/YY)	Enter Nonstructural Detail Number Used In Repair
Overhead Elements						
Suspended cable tray supports are braced (Detail 3.1).				Enter length of tray in feet:	__/__/__	
Suspended space heaters are anchored to the structure, have flexible gas pipe connections, and have braced unit legs (Detail 10.7).				Enter number of units:	__/__/__	
Suspended duct systems are braced along their entire length (Detail 10.6).				Enter length of duct system in feet:	__/__/__	
Suspended piping is braced to wall studs and or anchored to the ceiling structure (Detail 9.6).				Enter length of pipe in feet:	__/__/__	
Piping that goes across a seismic joint has a flexible connector installed at the joint (Detail 9.6).				Enter number of seismic joints:	__/__/__	
Pipe sleeve wall openings have a diameter at least 2 inches larger than the diameter of the pipe (Detail 9.6).				Enter number of openings:	__/__/__	

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School Name:_____ Classroom # or Name of Space Inventoried:_____ Inventory Date:_____ Inventory By (Name):_____ Date Copy Sent to District:_____	Check If Nonstructural Element Is NOT Present	Check If Condition Is OK	Check If Condition Needs Correcting	Enter Quantity Of Each Nonstructural Element To Be Corrected	Enter Date Condition Was Corrected (MM/DD/YY)	Enter Nonstructural Detail Number Used In Repair
Pipes are not supported by other pipes (Detail 9.6).				Enter number of places support occurs:	__/__/__	
Flexible pipe connections are used where pipes connect to equipment (Detail 9.6).				Enter number of pieces of equipment:	__/__/__	
Wall Elements						
Day tanks are anchored to the wall.				Enter number of tanks:	__/__/__	
Electrical panel is anchored to the wall.				Enter number of panels:	__/__/__	
Free Standing Equipment						
Water pump(s) are anchored to the floor (Detail 6.3).				Enter number of pieces of equipment:	__/__/__	
Flush tanks.				Enter number:	__/__/__	
Emergency power system battery sets are secured to racks and racks are anchored.				Enter number:	__/__/__	

School Name:_____ Classroom # or Name of Space Inventoried:_____ Inventory Date:_____ Inventory By (Name):_____ Date Copy Sent to District:_____	Check If Nonstructural Element Is NOT Present	Check If Condition Is OK	Check If Condition Needs Correcting	Enter Quantify Of Each Nonstructural Element To Be Corrected	Enter Date Condition Was Corrected (MM/DD/YY)	Enter Nonstructural Detail Number Used In Repair
Emergency power system elements, (including the motor generator set, fuel supply tank, muffler, electric cable, and power transfer unit) are anchored to the structure and braced (Detail 3.3).				Enter number of pieces of equipment:	__/__/__	
Water heaters are anchored to the floor and wall (Detail 9.7).				Enter number of pieces of equipment:	__/__/__	
Boilers are anchored to the concrete pad, the pad is anchored to the floor, piping is braced, and flexible connections are installed where the gas pipeline connects to the boiler.					__/__/__	
HVAC units are equipped with restraints or seismic snubbers (Detail 9.2).				Enter number of pieces of equipment:	__/__/__	
Wheel-mounted furniture is equipped with wheel-locks or tethers; objects on top of wheel-mounted furniture like test equipment are strapped on (Detail 6.10).				Enter number of pieces of equipment:	__/__/__	

Emergency Supplies, Equipment, And Information

Yes	No	
		Flashlights are available in each room.
		Tools to turn off utilities are easily accessible.
		School staff knows the location of utility shut-off controls.
		School staff knows how to turn off utilities.

Comments

5. Exterior Spaces

School Name:_____ **Classroom # or Name of Space Inventoried:**_____ **Inventory Date:**_____ **Inventory By (Name):**_____ **Date Copy Sent to District:**_____	**Check If Nonstructural Element Is Not Present**	**Check If Condition Is Ok**	**Check If Condition Needs Correcting**	**Enter Quantity Of Each Nonstructural Element To Be Corrected**	**Enter Date Condition Was Corrected (MM/DD/YY)**	**Enter Nonstructural Detail Number Used In Repair**
Canopies located at building entrances are anchored to the structure of the building (Detail 4.1).				Enter number of canopies:	__/__/__	
Unreinforced masonry chimneys do not extend above the roof surface more than twice the smallest chimney dimension. Masonry chimneys are anchored to the floor and roof and braced at the roof (Detail 5.1).				Enter number of chimneys and the height of each:	__/__/__	
Masonry parapets and cornices are braced where the height is greater than 1.5 times the thickness (Detail 5.2).				Enter the length in feet of parapet walls:	__/__/__	
Exterior masonry or concrete walls are anchored at each floor level and at the roof at a spacing of 4 feet or less (Detail 5.3).				Enter the width and height of each wall in feet:	__/__/__	
Building entrances are protected from falling bricks, gables, cornices, parapet walls, or decorations (Detail 5.2).				Enter the number of unprotected entrances:	__/__/__	
Covered walkways are strengthened to resist lateral earthquake forces without collapse.				Enter the length of walkway in feet:	__/__/__	
Vending machines are anchored to the floor and adjacent walls (Detail 6.8).				Enter the number of pieces of equipment:	__/__/__	

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School Name:_____ **Classroom # or Name of Space Inventoried:**_____ **Inventory Date:**_____ **Inventory By (Name):**_____ **Date Copy Sent to District:**_____	**Check If Nonstructural Element Is Not Present**	**Check If Condition Is Ok**	**Check If Condition Needs Correcting**	**Enter Quantity Of Each Nonstructural Element To Be Corrected**	**Enter Date Condition Was Corrected (MM/DD/YY)**	**Enter Nonstructural Detail Number Used In Repair**
Natural gas meter and building are **both** located on a firm, engineered soil.					__/__/__	
Natural gas piping does not enter building over building entrances.				Enter the number of entrances with piping:	__/__/__	
The natural gas distribution piping on-site is extensive and serviced by a single meter.				Enter number of buildings and square footage of each serviced by a single meter:		
Exterior wires do not pass over evacuation routes or outside assembly areas (Detail 3.4).					__/__/__	
Rooftop heating units or ducts are anchored and braced to the building structure (Detail 9.3).				Enter the number of pieces of equipment:	__/__/__	
Rooftop mechanical units are anchored to the roof structure (Detail 9.4).				Enter the number of pieces of equipment:	__/__/__	
Propane tanks are secured to concrete pad or are restrained by bollards (Detail 8.3).				Enter the number of pieces of equipment:	__/__/__	

Emergency Needs Available

Yes	No	
		A survey of the on-site gas distribution system has been completed. While in some instances an automatic shut off value on the main gas meter may be an effective measure to reduce potential gas leaks, such a valve may not be effective in some circumstances. Other actions may provide better protection from potential gas hazards. The variation in gas system characteristics from building to building makes a generic recommendation inappropriate.
		A grounds program is in place that addresses vegetation hazards, such as fragile trees that could overturn and cause building damage or damage to electrical service, excessive vegetation that could prevent access to and observation of areas near school buildings or generate fire hazards.
		The nearest pay phone has been identified in case on-site service does not function. Pay phones may function when site service does not. Test internal phone system to determine if service is delayed or unavailable by blowing into the speaker. If noise is heard in the earpiece, the system is delayed. If this is an emergency, do not hang up or click the connection, as that will place you at the end of the cue.

SCHOOL FACILITIES MANUAL
Nonstructural Protection Guide

SECTION C

DETAILS FOR PROTECTING NONSTRUCTURAL ELEMENTS FROM EARTHQUAKE-INDUCED DAMAGE

CONTENTS:

INSTALLATIONS NOTES FOR THE DETAILS IN SECTION C

COMMUNICATIONS / 1.0

DATA PROCESSING / 2.0

ELECTRICAL SYSTEMS / 3.0

EXITING / 4.0

EXTERIORS / 5.0

FURNISHING AND EQUIPMENT / 6.0

GLAZING / 7.0

HAZARDOUS MATERIALS / 8.0

MECHANICAL SYSTEMS / 9.0

OVERHEAD ELEMENTS / 10.0

PARTITIONS / 11.0

NONSTRUCTURAL PROTECTION DETAILS

Installation Notes For The Details In Section C

Most of the details and methods shown in this manual are general in nature and lack many of the specifics usually found in construction details. The reason for this is simply that the enormous variety of field conditions found in our schools requires a generalized approach, since specific details to fit every situation would lead to additional complexity in the document without necessarily clarifying the issue for users.

Because of the generalized approach taken in the document, it is necessary for users to apply common sense in the application and supply suggestions noted in each detail. The sizes and methods given should be sufficient for the vast majority of cases found in the field, provided care is taken in the selection of material lengths and in the substitution of materials.

The key parameter to bear in mind when completing the installation of most of the details in this guide, is that, when connecting a nonstructural element to a support system, it is important to maintain a direct load path between the nonstructural element and the surrounding structural or nonstructural system which will act as support. The most obvious instance is securing bookshelves or racks to a wood stud wall. Here, it is very important to make sure that the lag bolts or wood screws connecting the brackets to the wall itself are securely embedded in the wood studs. The plaster or gypsum wallboard is not a part of the structure and cannot be relied upon to provide an adequate resistance to seismic forces generated in the nonstructural element as they try to traverse the bracket and enter the wall. Another way of thinking of this problem is to make sure that when attaching any nonstructural element to a support, the support must be stronger than either the nonstructural element or the bracket.

When choosing supplies for which a diameter, but not a length is specified (for instance, wood screws), select a length such that at least three time the diameter of the screw will find purchase in the underlying structure. For instance, a 3/8" lag bolt designed to be attached to a wood stud should penetrate the stud at least 1-1/8". Adding to this length the thickness of intervening materials and the bracket itself will give the required length of the screw. When connecting an expansion bolt to concrete, select a bolt length based on the diameter given in the document so that the minimum embedment in concrete will be as specified by the manufacturer. In many cases, manufacturers mark their bolts to show minimum embedment. If such a designation is not present on the bolt, assume an embedment of five times the bolt diameter.

Care must also be taken, in the installation of any screw or bolt to maintain a minimum edge distance between the edge of support material and the centerline of the bolt or screw. Spacing of elements is usually not critical in these details. Edge distance in wood should be at least 1-1/2 times the diameter of the connector, and in concrete, an edge distance of 6 times the diameter should be maintained.

For those details where professional engineering consultation is recommended, installers should not attempt to install the detail based on the information provided in this manual. Consultation is recommended when either the circumstances are likely to vary widely or where the life safety hazard posed by the element is higher than for most nonstructural elements. The services of a professional structural engineer are necessary to determine the specific and technical requirements of each situation.

DETAILS FOR PROTECTING NONSTRUCTURAL ELEMENTS

Nonstructural Components

Nonstructural components are typically located in the architectural, mechanical, and electrical systems of a building. They include such items as:

- Partitions
- Ceiling and light systems
- Parapets and chimneys
- Mechanical and electrical equipment
- Piping
- Ducts

Other nonstructural components are building contents and furnishings such as:

- Shelving and their contents
- Computer equipment
- File cabinets

Nonstructural Component Evaluation

For nonstructural component evaluation, the key issue is generally whether the component or item is anchored or braced. Visual inspection can usually identify these components.

Nonstructural components become hazards to life safety when they slide, break, or fall during an earthquake. They may injure occupants or block exits from the room or building.

Purpose

To secure communication equipment racks.

Caution

- The weight of the rack and equipment should not exceed 250 pounds.
- When anchoring to post-tensioned slab, locate and avoid reinforcing.

Recommendation

Racks Less Than 6 Feet Bolt to the floor in all four corners.

Racks More Than 6 Feet Bolt to the floor in all four corners and add a brace to the top of the rack.

Supplies Required

- Expansion bolts—1/2" diameter (concrete)
- Lab bolts—1/2" diameter (wood)
- Sheet metal screws—No. 12
- Angle—2" × 2" × 1/4"

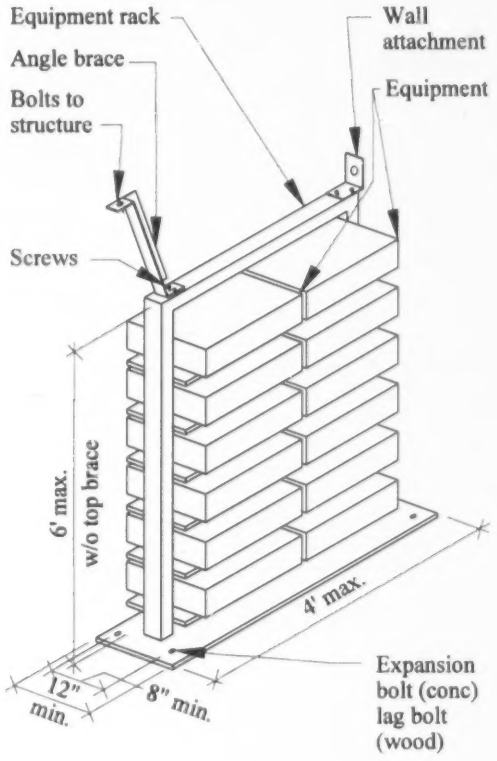
Installation

1. Anchor the rack to the floor in each of the four corners.
2. Install an angle brace at each end of the top of the rack to the adjacent wall or the structure above.
3. Attach the angle brace to the rack using sheet metal screws.
4. Attach the angle to the structure with lag bolts for wood and embed them into studs at least 2". (Do not attach to gypsum wallboard only.)
   OR
   Secure the angle to concrete with expansion bolts.

Note

This detail assumes the following:

- The rack meets the ANSI C 83.9-1972 and EIA RS-310-B Standard.
- The rack strength is equivalent to Harris Corp., Dreacon Division brand rack.



Standard Equipment Rack

Purpose

To secure access floors.

Recommendation

Install braces and anchor the existing pedestals. When floor height exceeds 12", install a steel brace to every third pedestal 8′ on center.

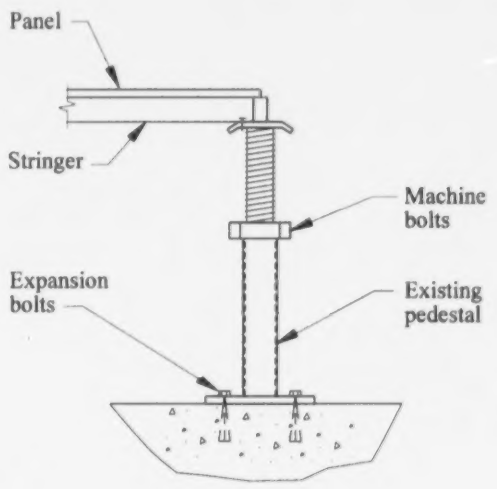
Supplies Required

- Expansion bolts—3/8" diameter
- Machine bolt—3/8" diameter
- Angle—1-1/2" × 1-1/2" × 1/4"

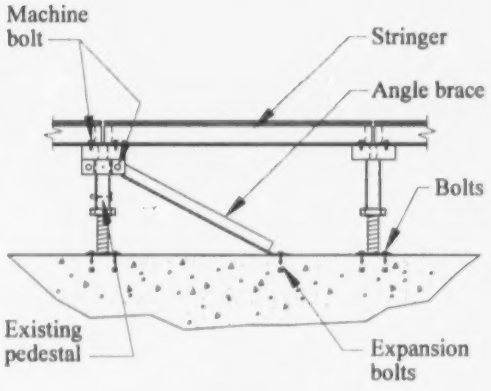
Installation

1. Install four expansion bolts through each pedestal base to the floor below (concrete floors).
2. Install a steel brace with a machine bolt or weld between the diagonal steel brace and the pedestal head with expansion bolts to the floor below.
3. Locate braces at 8' on center. At each location, install two braces in perpendicular directions.
4. Secure pedestal head to the stringer or to each floor panel corner with one machine bolt.

Caution
When anchoring to post-tensioned slab, locate and avoid penetrating reinforcing.



Short Pedestal System



Braced Pedestal System

Purpose

To secure computer equipment and other furniture and equipment located on the raised access floors.

Note

Typical equipment to anchor or brace:

- Main frame
  - — Processors
  - — Power distribution unit
  - — Coolant distribution unit
  - — Control console
- Large storage facilities
- Telecommunications equipment and modern
- Cabinets
- Air handling units

Caution

Verify that internal components have low vulnerability to vibrating motion. If internal components require vibration isolation, provide motion isolators in accordance with the manufacturer's requirements.

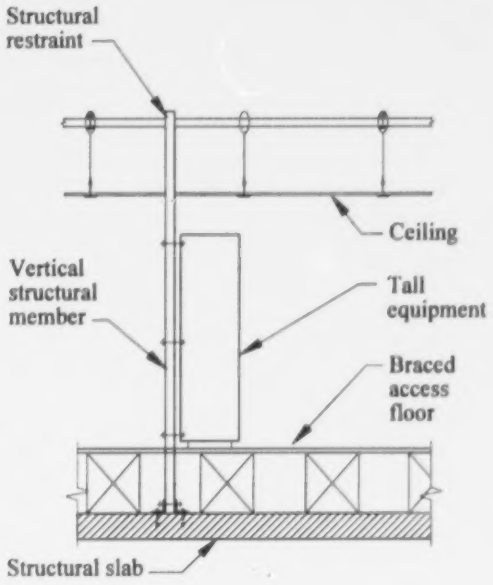
Recommendation

Install seismic bracing or anchors for computer equipment with the following characteristics:

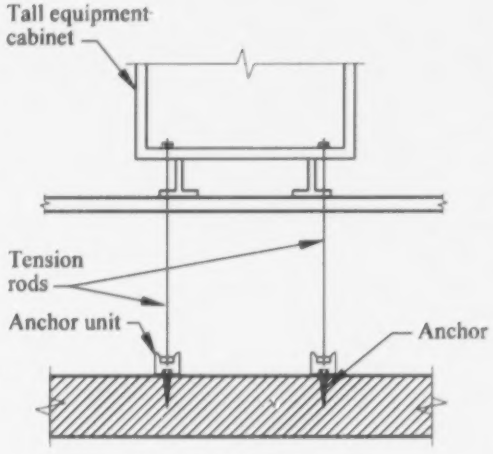
Height Height is greater than 2-1/2 times the base width.

Spacing Closely spaced or less than 18" apart on ground floor.

Consult a structural engineer for design of bracing or anchors.



Vertical Seismic bracing



Through-Floor Anchor System

Purpose

To secure computer equipment on an access floor.

Caution
Verify that internal components have low vulnerability to vibrating motion. If internal components require vibration isolation, provide motion isolators in accordance with Section 2.4.

Recommendation

Install high friction, rubber-based leveling pads for computer equipment with the following characteristics:

Height Height is less than 1/2 the base width.

Spacing Adequate spacing* between equipment to prevent impact.

Cabinet Strong, stiff cabinet.

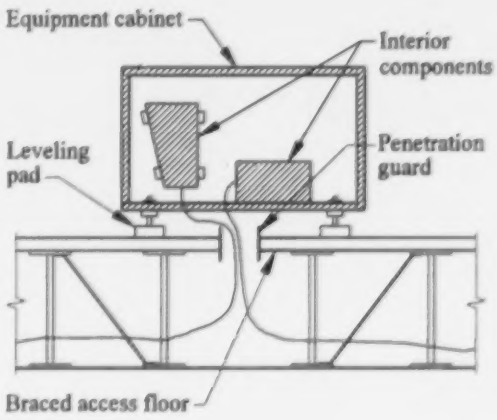
*Adequate spacing is either equipment that is spaced 3' or more apart or equipment that is tied together.

Supplies Required

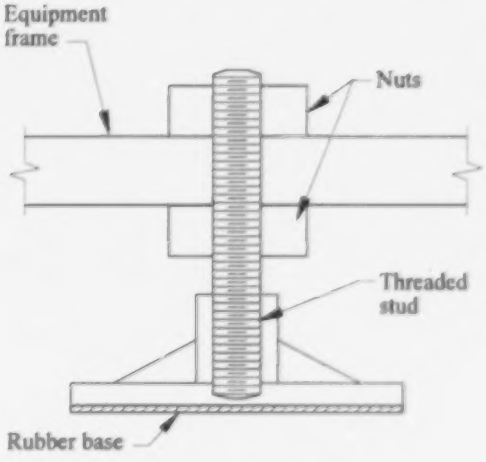
- Seismic leveling pads (with rubber base)
- Floor penetration guard

Installation

1. Provide leveling pad below each corner of equipment.
2. Provide penetration guard around opening in access floor.



Secured Equipment



Leveling Pad

Purpose

To secure computer equipment on an access floor.

Note
Seek engineering assistance for the design of the tether spring. Typical equipment to tether: ■ Disk drive controllers ■ Disk drives ■ High speed printers ■ Magnetic tape drives ■ Printer controllers ■ Tape drive controllers

Recommendation

Provide horizontal motion isolators for computer equipment with the following characteristics:

Height Height less than 1-1/2 times the base width.

Spacing Moderate spacing (1-1/2 to 3') between equipment.

Cabinet Flexible equipment cabinet that cannot be adequately strengthened or stiffened.

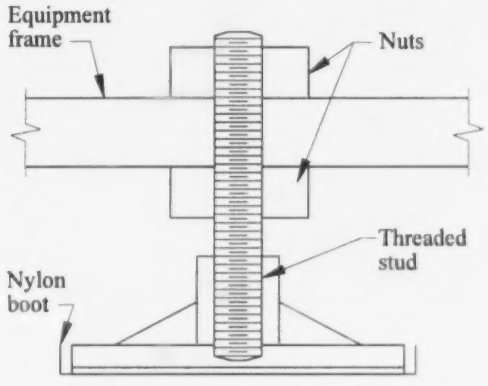
Internal Components Internal components with HIGH vulnerability to vibrating motion.

Supplies Required

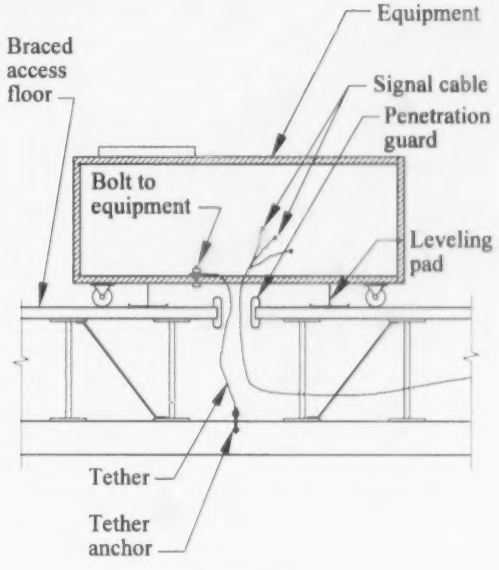
- Seismic level pads (with nylon boot)
- Floor penetration guard
- Steel cable tether (with springs)
- Eyebolt with expansion insert—1/2" diameter
- Machine bolt—1/2" diameter

Installation

1. Provide a leveling pad below each corner of the equipment.
2. Provide a penetration guard around access floor opening.
3. Provide more slack in signal cables than in tether.
4. Provide a steel tether between equipment and floor structure.



Leveling Pad



Isolated Equipment

Purpose

To secure cable trays.

Recommendation

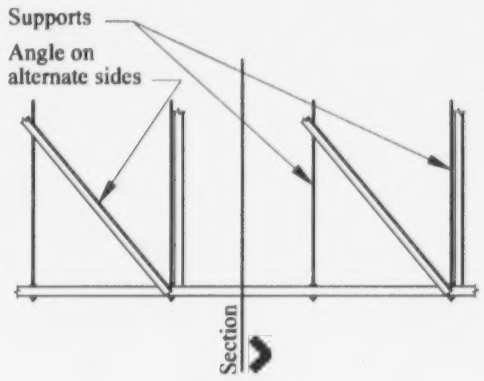
Strengthen existing supports with angles that are welded and braced.

Supplies Required

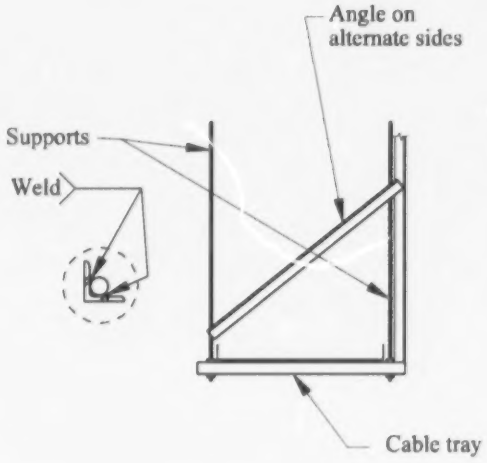
- Angle—1-1/2" × 1-1/2" × 1/4"
- Sheet metal screws—No. 10 × 3/4"

Installation

1. Brace cable tray with angles in two directions, installed diagonally at every other or alternate sides.
2. Weld angles to the supports or screw the top and bottom of the angles to the support with sheet metal screws.



Side View Of Cable Tray With Screws And Attached Braces



Section Through Cable Tray With Welded Brace

Purpose

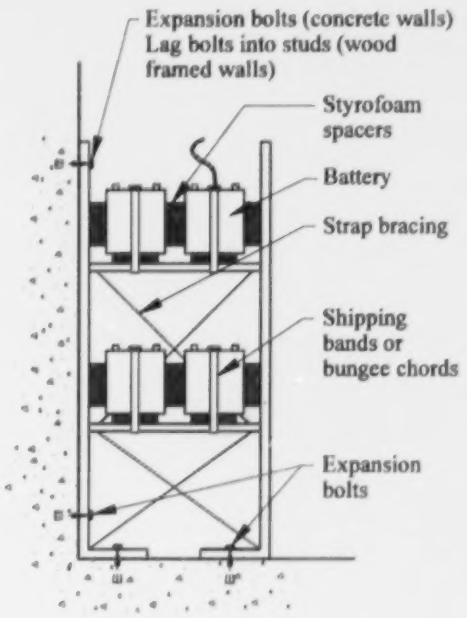
To anchor battery sets in the emergency power system.

Recommendation

Anchor battery sets to the building with bolts.

Supplies Required

- Angle—3" × 3" × 3/8"
- Angle—5" × 3" × 3/8"
- Expansion bolts—1/2" diameter
- Machine bolts—1/2" diameter
- Lag bolts—3/8" diameter × 4" (for wood)
- Styrofoam spacers
- Unistrut frames
- Velcro, nylon, or metal shipping bands
- Strap bracing—16 gage × 1"
- Sheet metal screws—No. 10
- Shipping bands or bungee chords



Wall-Mounted Battery Rack

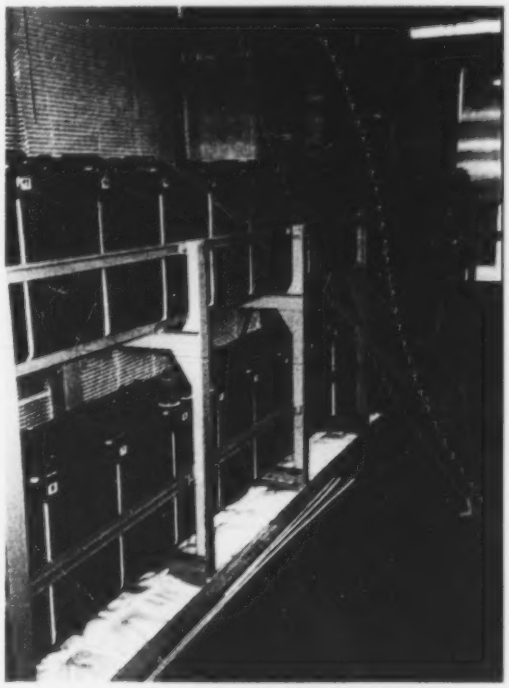
Installation

Free-Standing Battery Racks

1. Install angle (5" × 3" × 3/8") at each leg of the battery rack.
2. Bolt to the floor with expansion bolts and bolt to the rack with machine bolts.
3. Strap each battery to the rack with shipping bands.

Wall-Mounted Battery Racks

1. Bolt battery rack to wall and floor with expansion bolts. At wood-framed walls, secure to wall with lag bolts into studs. (Do not attached to gypsum wallboard only.)
2. Brace full height with X-bracing where wall support is unavailable. Provide two screws at each end of the X-bracing.
3. Strap each battery to the rack with shipping bands.



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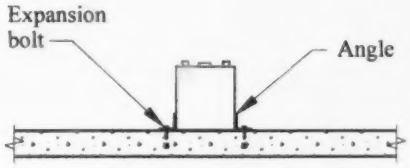
Single Battery On Floor

1. Install angle (3" × 3" × 3/8") on each side of battery rack.
2. Bolt each angle to the floor with two expansion bolts.



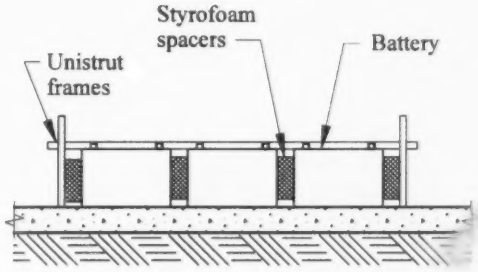
Single Battery On Floor

Multiple Batteries on Floor

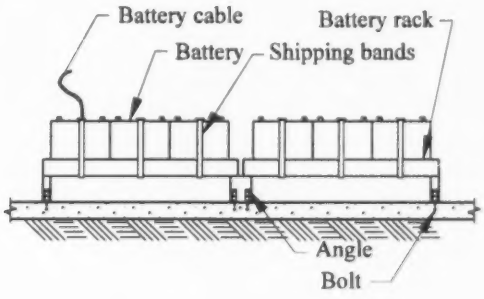
Provide unistrut frame secured to the floor.

Caution
When anchoring to post-tensioned slab, locate and avoid reinforcing.

Note
■ Provide slack in battery cables. ■ Place stryofoam spacers between batteries.



Multiple Batteries On Floor



Free Standing Battery Rack

Purpose

To secure emergency power system.

The emergency power system can include the following elements:

- Motor generator set
- Battery set
- Fuel supply tank
- Muffler
- Electric cable
- Power transfer unit

Recommendation

Install seismic snubbers to secure motor generator set.

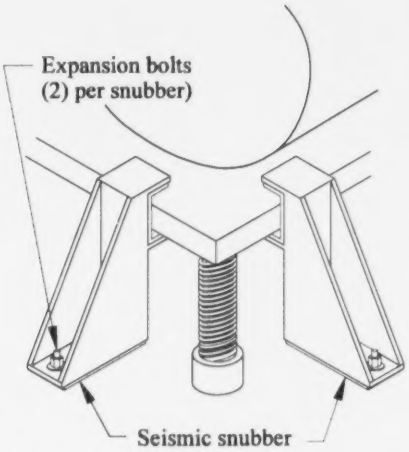
Supplies Required

- Eight steel Z snubbers (or other type of seismic snubber)
- Eight expansion bolts—1/2" diameter (for concrete)
  OR
  Eight expansion bolts—1/2" diameter (for wood)

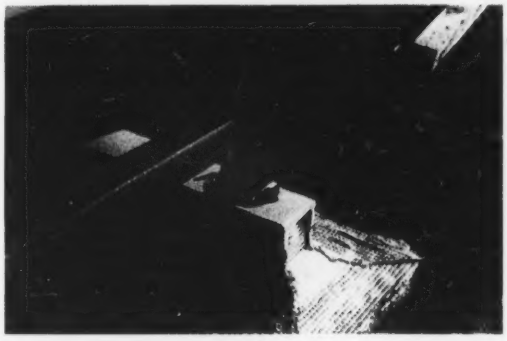
Installation

1. Place snubbers at two sides near the corners.
2. Bolt to the concrete or wood, allowing 1" free play between the generator and snubber.

Note
■ Due to size or complex design, motor generator sets and power transfer units may require more extensive mitigation design by a structural engineer. ■ Equipment may already be anchored directly without using isolation springs. Consult with structural engineer to determine if seismic snubbers are necessary.



Seismic Snubber



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Recommendation

Install steel braced platforms, metal straps, and slack line to secure fuel supply tank or water day tank.

Caution
When anchoring to post-tensioned slab, locate and avoid reinforcing.

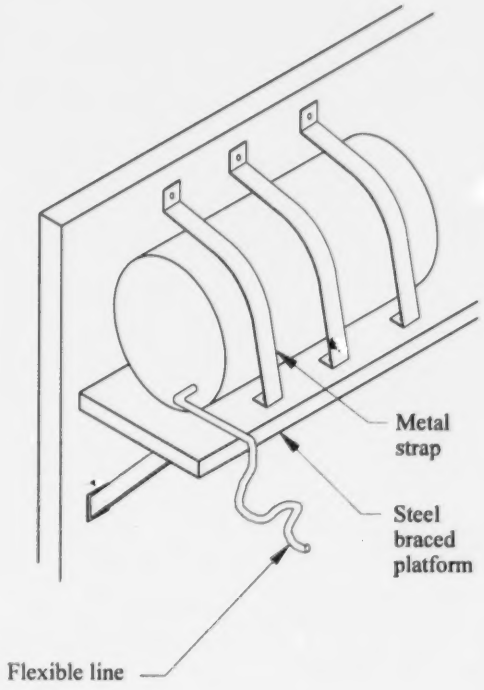
Supplied Required

- Steel-braced platform (Consult an engineer for design.)
- Metal straps (18 gage × 2")
- Sheet metal screws—3/8"
- Flexible line
- Lag bolts or expansion bolts—3/8"

Installation

1. Place a minimum of two straps (one at each end of the tank).
2. Secure straps to the steel-braced platform with sheet metal screws. Attach to supporting structure with lag bolts or expansion bolts.

Note
■ Provide slack in electrical cables. ■ Anchor each element in the system.



Fuel Supply Tank

Purpose

To prevent damage or injury from wires.

Caution
Exterior wires that are located overhead pose a hazard to anyone exiting a building during an earthquake.

Recommendations

Exterior Wires

To prevent damage or injury from exterior wires that are located overhead, follow these steps:

- Contact an electrician to replace external wires that are located overhead with underground wires.
- Designate an individual school staff to notify the local power company of downed power lines. (The designated individual will be responsible for providing information about downed power lines.)

Interior Wires

To prevent damage or injury from internal wires, follow these steps:

- Secure elements that could fall on wires.
- Provide slack in the wires where they connect to equipment, cross seismic joints, or extend through openings in the wall.

Note
During an earthquake, falling objects such as lights can disrupt power.

Purpose

To secure canopies.

Caution
Canopies may fall during an earthquake causing injury or death. Damaged canopies may also block entrances and exits.

Recommendation

Secure the canopy to the building to prevent from detaching.

Consult a structural engineer and architect to implement one of the following options:

- Increase the lateral capacity of the columns
- Add steel bracing at the columns
- Reconstruct the roof system with lightweight material
- Add plywood or concrete shear walls
- Install plywood at the roof
- Install additional anchors at the roof

Purpose

To secure doors and door frames.

Recommendation

Install latches or automatic door closers.

Caution
Free-swinging doors may cause injuries during an earthquake.

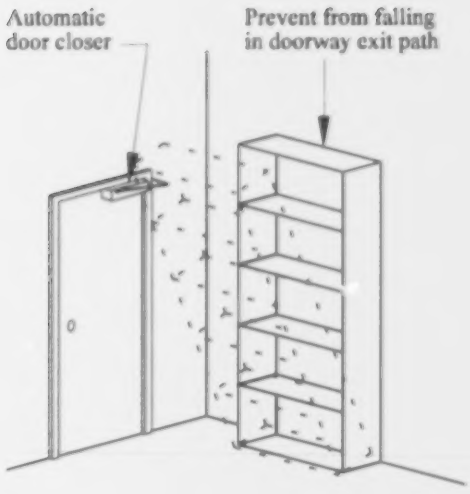
Supplies Required

- Mechanical latches
- Automatic door closers

Installation

1. Install mechanical latches on cupboard doors.
2. Replace magnetic latches with mechanical latches.
3. Install automatic door closers, particularly on exit doors.

Note
■ Keep doorways clear. ■ Secure or remove objects that may block doorways during an earthquake. ■ Secure sliding doors in the open position if possible.



Automatic Door Closer

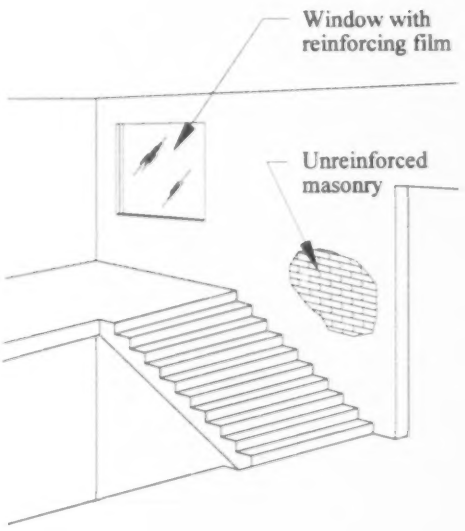
Purpose

To keep stairwells clear for exiting the building.

Recommendation

Consult a structural engineer to implement any of the following options:

- Remove or anchor all materials which may be loosened or fall during an earthquake.
- Reinforce or replace masonry walls and plaster (if not adequately reinforced) in the stairwell. Replace the wall with steel studs and sheetrock.
- Install battery-operated emergency lighting in stairwells.
- Reinforce windows (see Section 7.1).
- Secure ceiling (see Section 10.1).



Stairwell

Purpose

To secure chimneys.

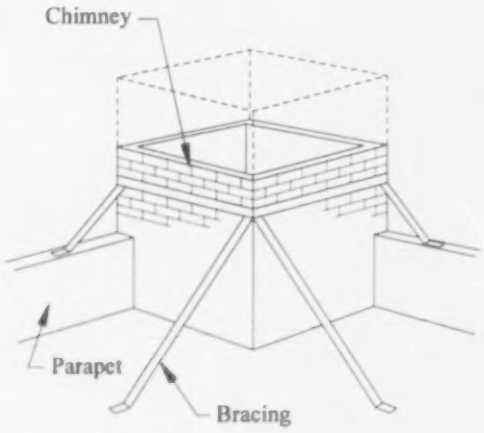
Caution
Chimneys that extend above the roof more than twice the least dimension of the chimney tend to crack just above the roof line. Chimneys may then fall through the roof or onto walkways below creating a life-safety hazard.

Recommendation

Consult a structural engineer to implement one or more of the following options:

- Remove chimney.
- Reduce chimney height to no more than twice the smallest chimney dimension.
- Brace the chimney.
- Fill the chimney with concrete.
- Install plywood reinforcing on the roof to prevent chimney bricks from falling through the roof to the rooms below.
- Tuckpoint deteriorated mortar in the chimney.

Note
■ The mechanical code requires specific heights and locations for the type of chimney used. These code requirements must be considered before selecting any of the options to secure the chimney. ■ Exterior walls may require additional strengthening if the wall supports a chimney and large windows.



Braced Chimney

Purpose

To secure parapets and cornices.

Recommendation

Consult a structural engineer to implement any of the options below, where parapet or cornice height is greater than 1.5 times the thickness, some overstrengthening is advisable.

Supplies Required

- Angle—3" × 3" × 1/4"
- Continuous angle and channel
- All-thread rod—3/4" diameter
- Lag bolts—3/4" diameter
- Epoxy grout
- Blocking—4" × 8"
- Clips—Simpson A 35
- Masonry wall anchor—Simpson LTT

Installation

8" Wall Thickness

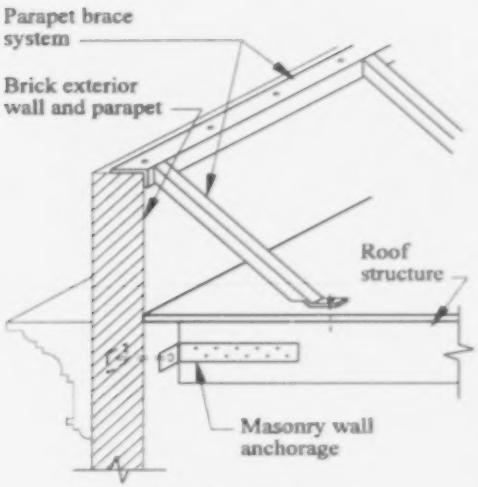
1. Attach continuous channel to the top of the parapet with all-threads embedded 12" and epoxy at 4' on center.
2. Weld 3" × 3" angle at 8' on center to continuous channel. Provide a lag bolt from the angle to a joist or blocking in the roof.

Caution
Parapets and cornices can detach during an earthquake, causing injuries and deaths.

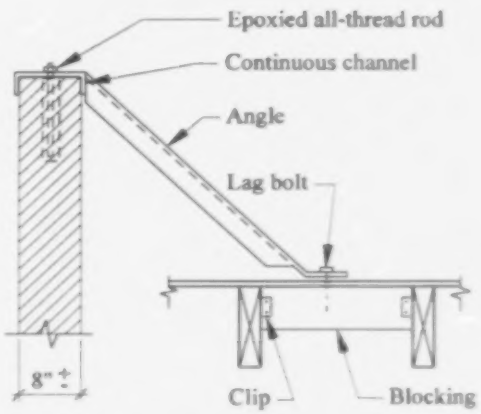
13" Wall Thickness

1. Attach continuous channel to the top of the parapet with all-threads embedded 12" and epoxy at 4' on center. Place all thread at least 6-1/2" away from the edge of the parapet.
2. Weld 3" × 3" angle at 8' on center to continuous channel. Provide lag bolt from angle to joist or blocking in roof.

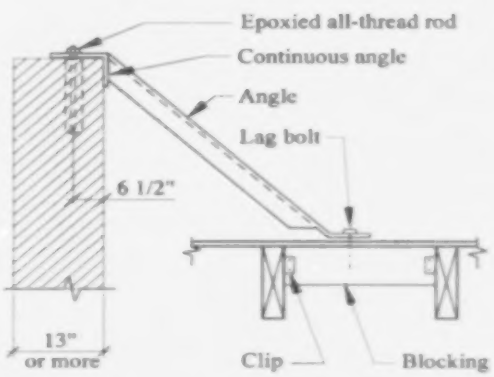
Note
Consult an architect for waterproofing details where structural connections penetrate roofing or flashing.



Parapet Brace System



8-Inch Wall Thickness



13-Inch Wall Thickness

Purpose

To anchor the walls to the roof/floor.

Recommendation

Install LTT anchors.

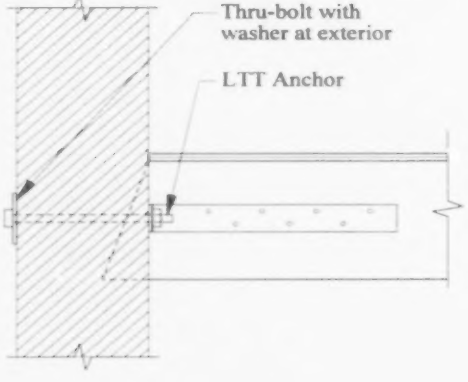
Supplies Required

- LTT anchors (manufactured by Simpson or equivalent)
- Thru-bolt—3/4" diameter
- Washer—3/8" × 6" diameter
- 2×___ blocking (depth to match existing joist depth)

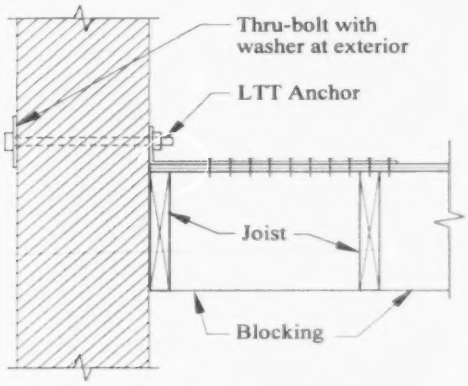
Installation

1. Install LTT anchors approximately every 4' on center.
2. Where existing joists are perpendicular to the wall, attached anchors to the sides at the top or bottom of the joists.
3. Where existing joists are parallel to the wall, install blocking to two joist spaces at the LTT anchor locations. Install anchors above or below blocking.

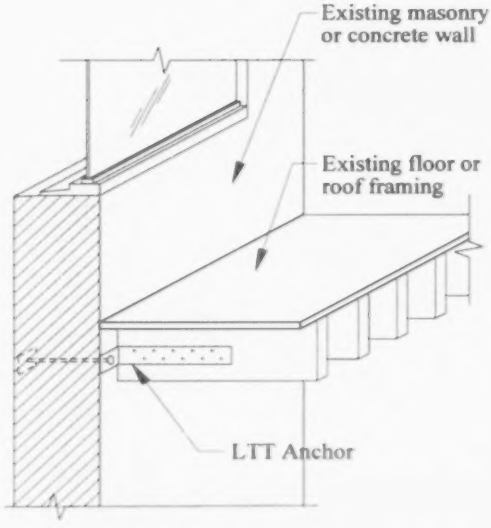
Note
If washers are not desired, as in historic buildings or terra cotta exteriors, epoxy an all-thread rod inserted into the wall a minimum 8".



Joists Perpendicular To Wall



Joists Parallel To Wall



Wall Section

Purpose

To secure desktop/countertop equipment.

Recommendation

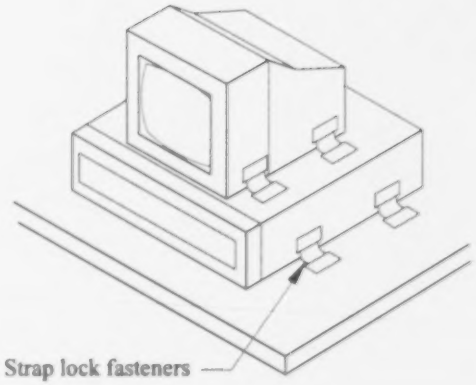
Install one of the following:

- Bungee cord
- Strap/lock fasteners
- Leash locks
- Earthquake pads

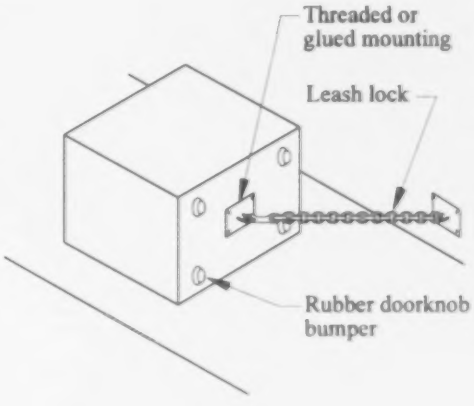
Note
■ Use leash locks for equipment that may be moved (for example, telephones, keyboards, laptops.) ■ Fasten near the top and near the bottom if equipment is more than two times as tall as it is wide.

Supplies Required

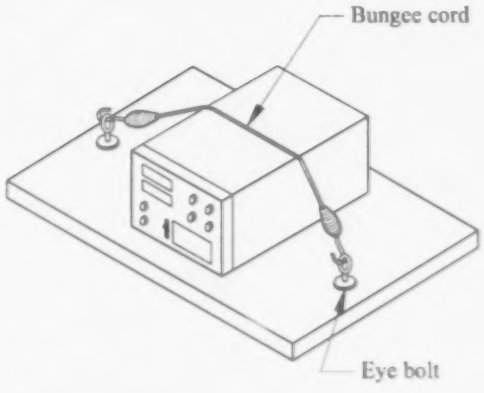
- Bungee cord
- Eye-bolts—3/16" diameter
- *Versa Grip* fasteners
- Lease locks
- Rubber doorknob bumpers
- Threaded or glued mounting



Versa Grip Fasteners



Leash Locks



Bungee Cord

Purpose

To secure file cabinets.

Recommendation

Anchor the file cabinets with clip angles.

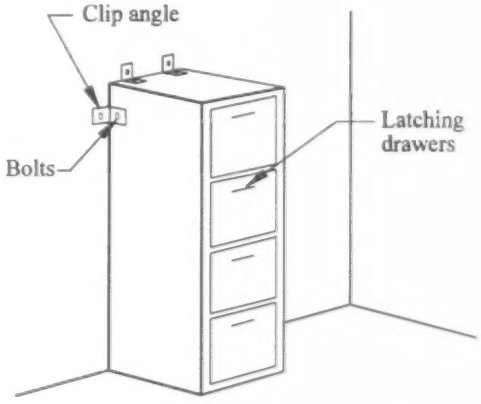
Supplies Required

- Clip angles—2" × 2" × 3/16"
- Lag bolts—1/4" diameter × 3" (for wood walls)
- Expansion bolts—3/8" diameter × 2" (for concrete walls)
- Top clips—2" × 3/32"
- Sheet metal screws—No. 10
- *Leash Lo*cks for drawers without latching locks
  OR
  Thumb Lock latches

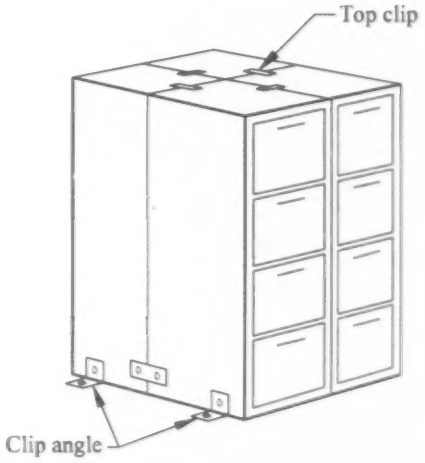
Installation

1. Anchor file cabinets with four or more drawers to wall stud with clip angles.
2. Use lag bolts for wood walls.
   OR
   Use expansion bolts for concrete walls.
3. Connect adjacent cabinets with top clips and sheet metal screws. Use clips near the cabinet bases.

Note
■ Fill file cabinets from the bottom up if it is not full. ■ Locate cabinets away from exits and hallways. ■ Do not place file cabinets so that the drawer opens toward the occupants of the room. ■ Keep cabinet drawers shut, locked, or secure with latches.



File Cabinets With Clip Angle



File Cabinets With Top Clips

Purpose

To secure floor-mounted objects that weigh less than 40 pounds.

Recommendation

Install a clip angle or a metal plate.

Caution
When anchoring to post-tensioned slab, locate and avoid reinforcing.

Supplies Required

- Clip angle—3" × 3" × 1/4"
- Metal plate—1/4" × 3" × 3"
- Expansion bolts—3/8" or 1/2" diameter × 2" to 4" (for concrete floors)
  OR
  Lag bolts—1/2" diameter × 4" (for wood floors)

Installation

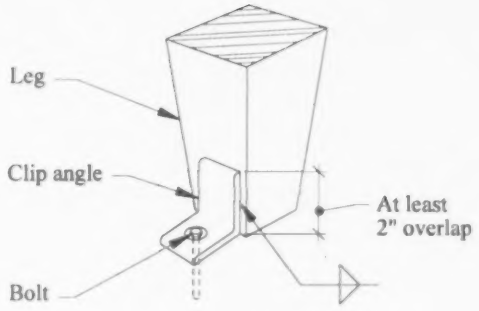
Clip Angle Installation

1. Weld a clip angle to leg (4" of 1/8" fillet).
   OR
   Secure clip angle with a lag bolt for wood legs or a machine bolt or steel legs.
2. Overlap clip angle 2" with the floor-mounted object.
3. Secure horizontal leg of angle with a lag bolt to wood or an expansion bolt to concrete.

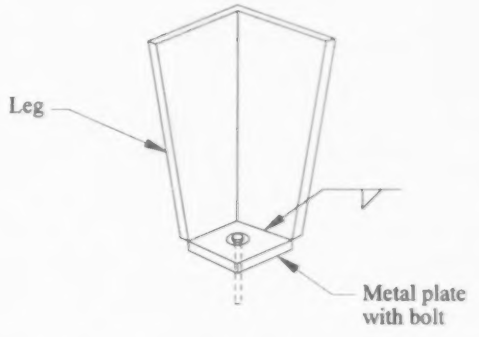
Metal Plate Installation

1. Weld the metal plate inside the leg of the object (4" of 1/8" fillet).
2. Secure the metal plate with a lag bolt to wood or an expansion bolt to concrete.

Note
■ If object is marked DO NOT BOLT TO FLOOR, locate it away from classrooms and people.



Clip Angle



Metal Plate

Purpose

To anchor lockers and cabinets.

Recommendation

Install a metal angle.

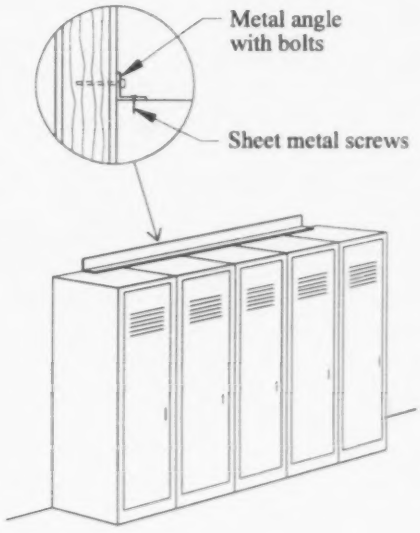
Supplies Required

- Metal angle—2" × 2" × 3/16"
- Sheet metal screws—No. 10 × 1-1/2"
- Lag bolts—1/4" diameter × 3" (for wood walls)
  OR
  Expansion bolts—3/8" diameter (for concrete walls)

Installation

1. Anchor metal angle to wall stud.
2. Use lag bolt for each stud in wood wall.
   OR
   Use expansion bolts at 32" on center for concrete walls.
3. Attach metal angle to each locker section with two sheet metal screws.

Note
■ If lockers or cabinets cannot be anchored, place them away from hallways and doors. ■ If lockers or cabinets are internally secured to walls, ensure that the attachments are directly to wall studs, masonry, or concrete. Toggle bolts to sheetrock will not prevent the lockers from topping.



Lockers

Purpose

To secure refrigerators.

Recommendation

Install angle brackets or pronged zee clips.

Supplies Required

- Angle bracket—4" × 2" × 1/8"
- Lag bolts—3/8" diameter × 4" (for wood)
- Expansion bolts—1/2" diameter × 4" (for concrete)
- Metal screws—No. 14
- Pronged zee clip

Installation

Angle Bracket Installation

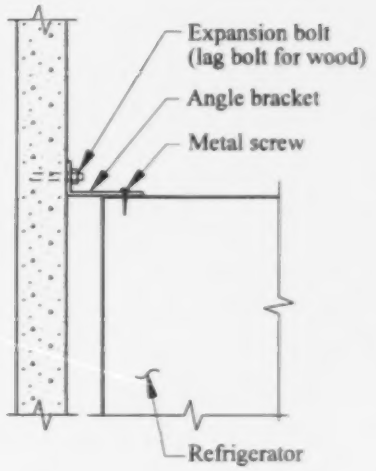
1. Secure the angle bracket to a wood wall with a lag bolt for wood.
   OR
   Secure to a concrete wall with an expansion bolt for concrete.
2. Use a metal screw to attach bracket to the refrigerator.

Pronged Zee Clip Installation

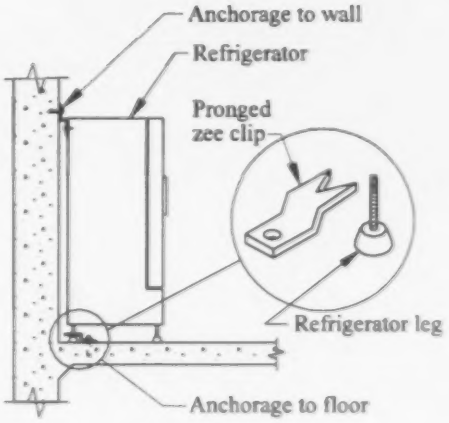
1. Align the angle the clip with the leg of the refrigerator.

Note
■ Place refrigerators and vending machines away from exits and hallways if possible. ■ Enclose refrigerators in a confined space (if possible) to prevent the machine(s) from tipping over.

Caution
When anchoring to post-tensioned slab, locate and avoid reinforcing.



Wall Anchorage



Floor Anchorage

Purpose

To secure shelf contents.

Recommendation

Use metal edge angles to secure large items or to secure items stored in high areas. Secure computers or typewriters to tables or shelves without lips with velcro patches on seismic mat.

Install one of the following:

- Metal edge angle
- Net restraints
- Seismic Mat

Supplies Required

- Metal edge angle—1-1/2" × 1-1/2" × 10" gage
- Small wood screws—No. 10 × 3/4"

Installation

Metal Edge Angle Installation

1. Add metal edge angles to shelving.
2. Screw platform with wood screws at 18" on center.

Recommendation

Use net restraints for items that are bulky or stored high.

Supplies Required

- Net restraints—nylon netting
- Eye-hooks

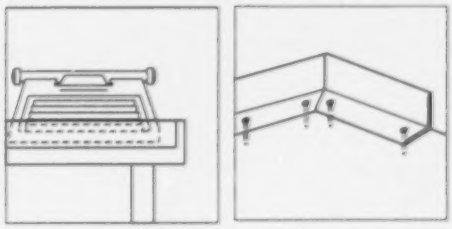
Installation

Net Restraint Installation

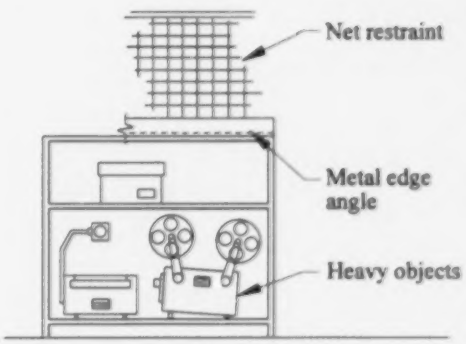
Secure nylon netting with eye-hooks.

Note

- Do not use metal edge angles where top heavy items are stored.
- Store heavy objects as low as possible.
- Restrain boxes on shelves.



Shelf Lip **Metal Edge Angle**



Securing Large Items

(Continued)

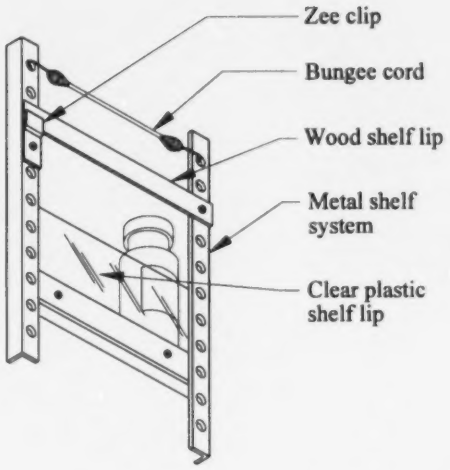
Recommendation

Use zee clips, bungee cords, or velcro to secure small items.
OR
Use shelf lip for small items.

Supplies Required

- Zee clips
  OR
  Shelf lip
- Bungee cord or wire
- Velcro
- Clear plastic or wood shelf lip
- Nylon netting

Note
▪ Make sure shelving is securely attached to walls. ▪ Contain small items in boxes.



Securing Small Items

Purpose

To secure shelf units.

Recommendation

Install clip angles and steel struts for shelf units weighing less than 250 pounds.

Supplies Required

- Clip angles—1-1/2" × 1-1/2" × 1/8" (4' maximum spacing)
- Lag bolts—3/8" diameter (for wood shelving)
- Expansion bolts—3/8" diameter (for concrete floors and walls)
- Steel strut—1-1/2" × 1-1/2" × 1/8"
- Sheet metal screws—No. 10 × 3/4"
- Machine bolts—1/4" diameter
- Wood screws—No. 10 × 3/4"
- Steel plates—1/8" × 3" × 6"
- Strap bracing—16 gage × 1"

Installation

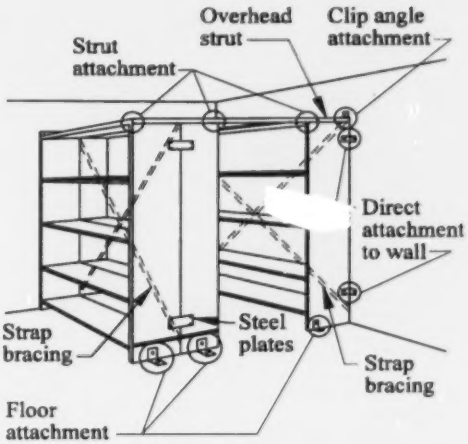
Clip Angle - Wall Attachment

1. Attach the shelf unit directly to the wall with a clip angle.
2. Secure the unit to the wall with a lag bolt for wood. Embed it into a stud at least 2". (Do not attach to gypsum wallboard only.)
   OR
   Secure to wall with an expansion bolt for concrete.

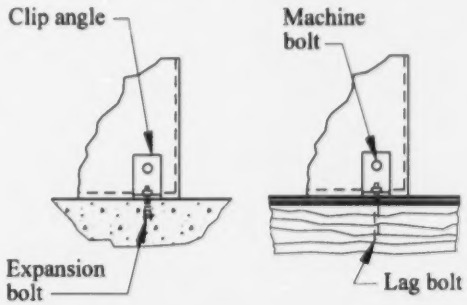
Clip Angle - Floor Attachment

Attach a clip angle to a concrete floor with expansion bolts.
OR
Attach a clip angle to a wood floor with lag bolts.

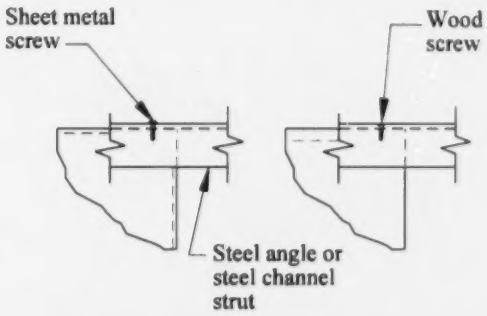
Caution
When anchoring to post-tensioned slab, locate and avoid reinforcing.



Shelf Unit Attachment



Concrete Or Masonry Floor **Wood Floor**



Metal Shelving **Wood Shelving**

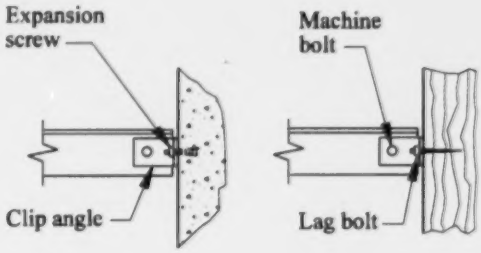
(Continued)

Steel Strut Installation

Overhead Strut Attachment

Secure overhead strut with screws to shelving.

Note
■ For shelf units that weigh over 250 pounds (including contents), consult a structural engineer. ■ Attach shelving to frames. ■ Connect adjacent shelf units with steel plates and machine bolts. ■ Install strap bracing across back of shelving. Provide three screws at each end of the bracing.



Concrete Or Masonry Wall **Wood Wall**

Purpose

To secure vending machines.

Recommendation

Use angle brackets and pronged zee clips.

Caution
When anchoring to post-tensioned slab, locate and avoid reinforcing.

Supplies Required

- Angle bracket—4" × 2" × 1/8"
- Lag bolts—3/8" diameter (for wood)
- Expansion bolts—1/2" diameter × 4" (for concrete)
- Metal screws—No. 14
- Pronged zee clip

Installation

Angle Bracket Installation

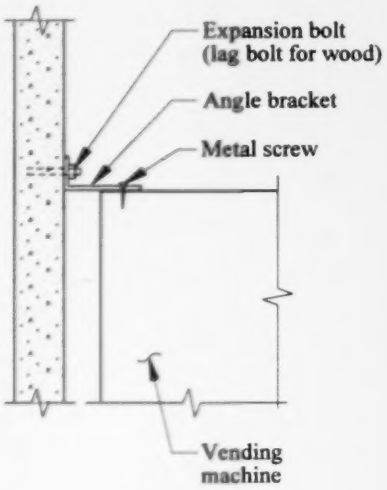
Contact vending service company to install angle brackets.

1. Secure angle bracket to wall with a lag bolt for wood.
   OR
   Secure to wall with an expansion bolt for concrete.
2. Attach bracket to the vending machine with metal screws.

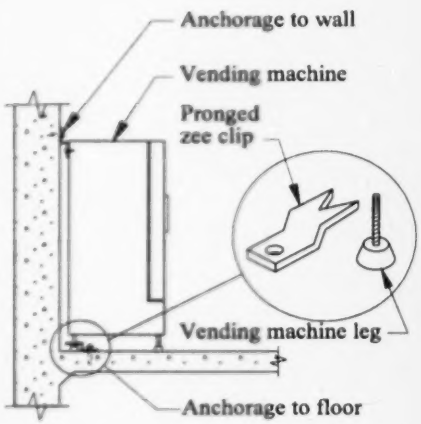
Pronged Zee Clip Installation

Align the clip with the leg of the vending machine.

Note
■ Locate vending machines away from exits and hallways if possible. ■ Enclose vending machine in confined space (if possible) to prevent the machine(s) from tipping over. Do not locate machine so as to impede servicing.



Wall Anchorage



Floor Anchorage

Purpose

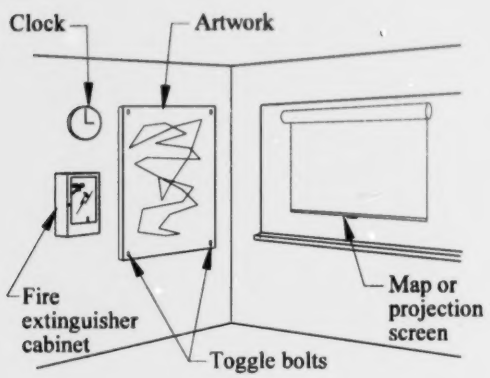
To secure wall-mounted objects.

Recommendation

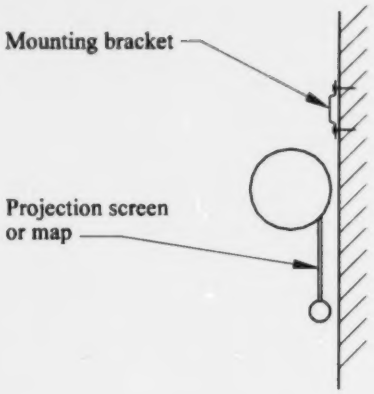
- Secure wall-mounted objects to the wall using either brackets, toggle bolts, or retention straps.
- Secure projection screen by attaching it to a wall with two brackets.
- Secure artwork by attaching it to a wall with four toggle bolts.

Supplies Required

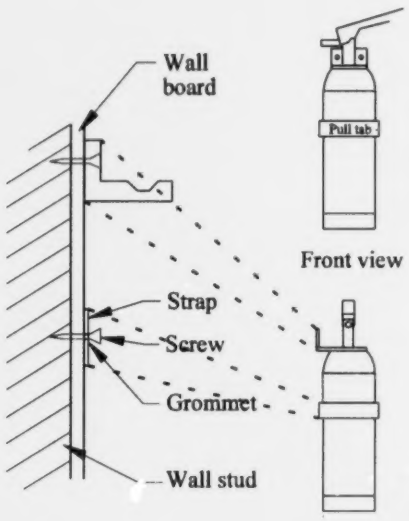
- Brackets (including screws)
- Toggle bolts—1/4" diameter
- Retention strap with velcro pull tab, grommet, and 1-1/2" × 1/8" diameter screw



Wall-Mounted Objects



Maps, Projection Screens And Artwork



Fire Extinguisher With Retention Strap

Purpose

To secure wheel-mounted furniture.

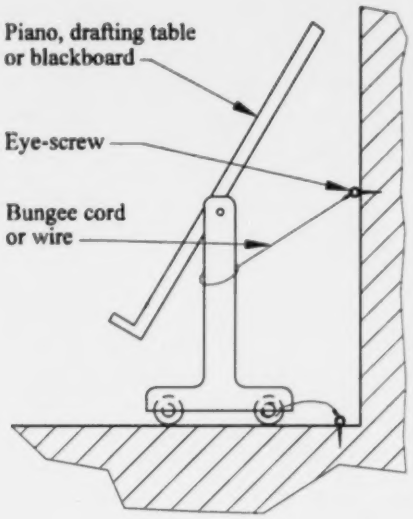
Note
■ As shaking increases, furniture may slide or—if it is top heavy—it may overturn. ■ Position wheel-mounted furniture away from occupants in the room.

Recommendation

Install restraints.

Supplies Required

- Eye-screws—1/4" diameter × 3"
  OR
  Eye-screws—1/2" diameter (for furniture over 1,000 lbs.)
- Restraints—Bungee cord or 1/8" diameter wire



Anchoring Wheel-Mounted Furniture

Installation

Wheel Lock Installation

Follow manufacturer's instructions.

Note
■ Wheel locks can prevent furniture from rolling during moderate shaking. ■ Be consistent is setting wheel locks, returning furniture to storage, and tethering furniture. ■ The need to move of furniture may eliminate permanent restraint options.

Restraint Installation

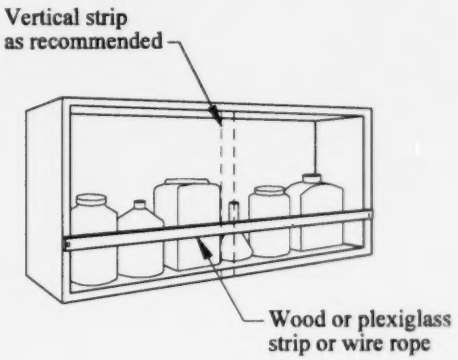
1. Tether each leg to a wall or floor with bungee cord or wire when the furniture is not in use.
2. Tie a cord or wire to an eye-screw that has been screwed into the wall. Attach the cord or wire to the eye screw.

Purpose

To reduce risks from breaking glass.

Note
■ Large windows pose the greatest risk to safety. ■ Locate seating away from windows to avoid injuries from shattering glass or untreated windows. ■ Lower window blinds or close drapes if possible.

Caution
■ Consult a structural engineer to determine if window frame is designed to support glass in the vent of a building. ■ Do not coat or replace any glass panes if the coating or new glass would cause a large pane to drop as a unit.



Open Shelves

Recommendation

- To reduce the risks at glass windows, doors with glass, display cases, and skylights, follow the steps below.
- Store glassware or glass objects in closed cabinets (see Section 6.6) or restrain them on open shelves (see Section 6.6)
- Refer to Section 6.9 to secure mirrors.

Supplies Required

- Wood or Plexiglas strip—1/8" × 1"
- Wood or sheet metal screws—No. 10 × 1"
- Wire rope—No. 12 gage

Installation

1. Reinforce glass with polyester film or similar material.
   OR
   Replace glass with Plexiglas or safety glass.
2. Place film on one side of the glass only.
3. Secure items in the display cases (see Section 6.6).
4. Anchor the display case to the wall (see Section 6.9).

Purpose

To reduce the potential for risks from chemical spills.

Recommendation

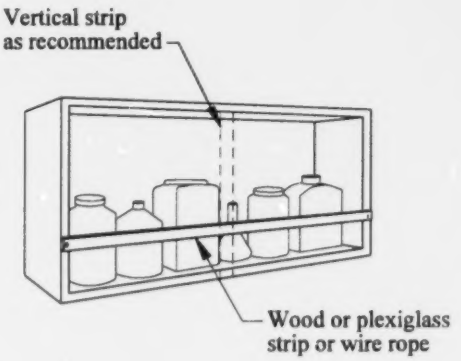
Install wood or Plexiglas strips or wires to restrain containers on open shelves.

Supplies Required

- Wood or Plexiglas strip—1/8" × 1"
- Wood or sheet metal screws—No. 10 × 1"
- Wire rope—No. 12 gage

Installation

1. Attach a wood or Plexiglas strip to the shelf with wood or sheet metal screws.
   OR
   Attach wire rope to the shelf with wood or sheet metal screws.
2. Secure the wire rope with three tight turns at each end.
3. Provide intermediate vertical strips where horizontal strips span more than 3'. Attach vertical strips to each shelf.
4. Place horizontal restraint high enough to restrain tall objects while allowing easy access. Provide additional horizontal restraint as required for shorter objects.



Open Shelves

Recommendation

Secure cabinet doors with mechanical latches.

Supplies Required

- Mechanical latches

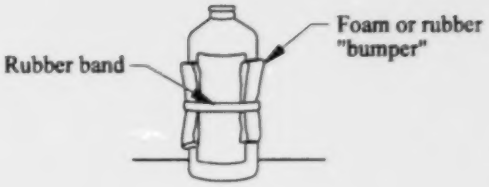
Installation

1. Provide mechanical latches on all doors. Test latches to assure that they can remain closed during severe shaking.
2. Replace magnetic latches with mechanical latches.

(Continued)

Recommendation

Wrap fragile bottles or dangerous materials with foam rubber or rubber bands to protect
OR
Replace glass containers with unbreakable containers.



Bottle With Foam Or Rubber "Bumpers"

Supplies Required

- Foam rubber or rubber
- Rubber bands

Note
■ Store acids and other volatile chemicals separately and as close to the ground as possible. ■ Store heavy containers as close to the ground as possible For more information on storage of chemicals and chemical interaction contact the Washington State Dept. of Ecology for: *Step-By-Step Guide for to Better Laboratory Management Practices, Publication No. 97-431, July 1997*

Purpose

To store and secure ccompressed gas cylinders or large fire extinguishers.

Recommendation

Secure cylinders with wire or rope.

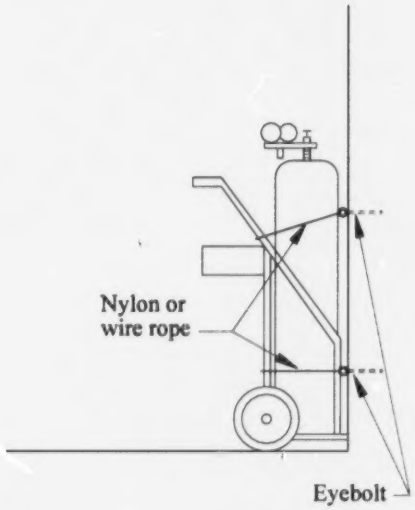
Supplies Required

- Wire or nylon rope
- Eye-bolts—1/4" diameter

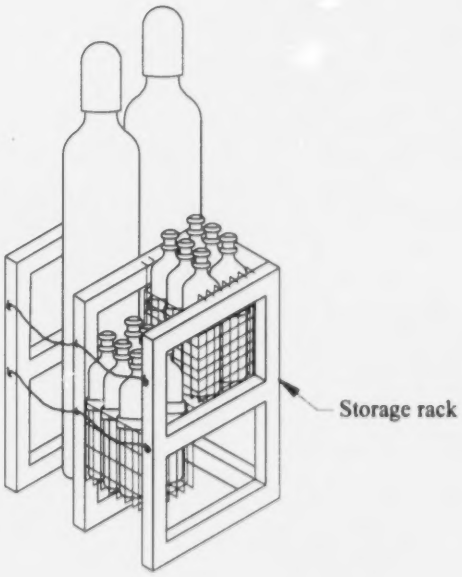
Installation

1. Strap top and bottom of cylinder and carrier with wire or nylon rope.
2. Secure rope with eye-bolts to the stud on each side of the canister.
3. For groups of cylinders, provide storage racks. Attach rope to racks.

Note
■ Store gas cylinders in a separate area. ■ Store cylinders away from people and exits.



Gas Cylinder



Group of Cylinders

Purpose

To secure propane tanks.

Caution
Large propane tanks will expand and contract. This may stress the tank wall or seismic connections. Consult a structural engineer and your propane supplier for assistance.

Recommendation

Install expansion bolts through existing brackets or provide steel pipe bollards. Steel pipe bollards are recommended for all large tanks.

Supplies Required

- Reinforcing steel—No. 4
- Expansion bolts
- Concrete (2,000 psi minimum)
- A36 steel pipe—6" diameter

Installation

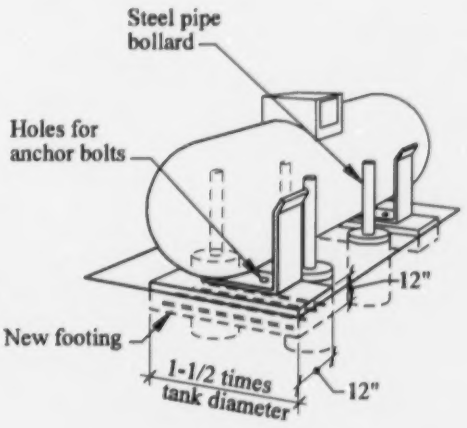
Expansion Bolt

1. Provide new footings (if none exist) at each bracket.
2. Install expansion bolts in existing bracket holes. Fill the hole with the largest diameter bolt possible.

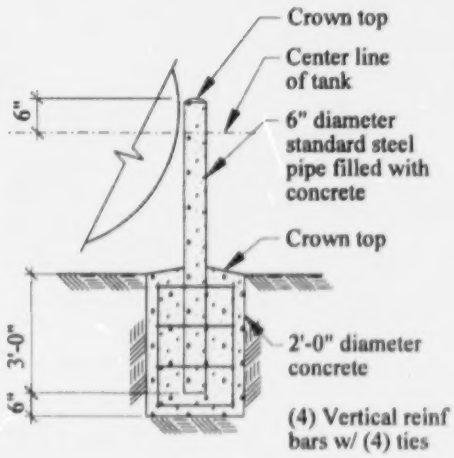
Steel Pipe Bollard

1. Provide bollards at one-quarter points on two sides of tank.
2. See steel pipe bollard figure for dimensions.

Note
Provide flexible supply line connections.



Propane Tank



Steel Pipe Bollard

Purpose

To secure filtration tanks.

Caution
When anchoring to post-tensioned slab, locate and avoid reinforcing.

Recommendation

Anchor filtration tanks.

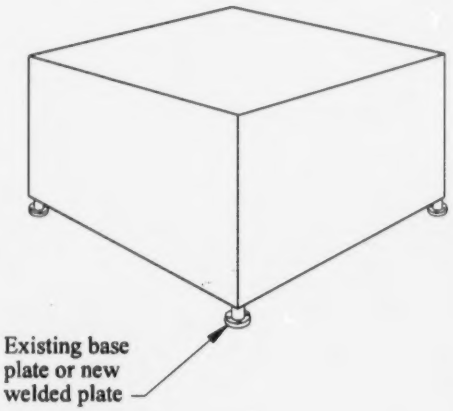
Supplies Required

- Expansion bolts (various sizes)
- Steel plate—1/4" × 8" × 8"

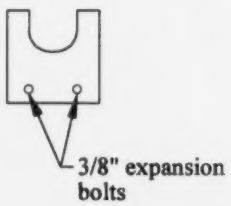
Installation

Anchor the tank at each leg with two expansion bolts that are the same diameter as the holes in the base plate.
OR
If a base plate hole cannot be accessed or does not exist, weld a plate to the existing base plate and secure this new plate with two expansion bolts (3/8") into the structure.

Note
■ Store granular chlorine so that it cannot fall into the tank during ground shaking. ■ Restrain chlorine gas cylinders (see Section 8.3).



Filtration Tank



Alternate Weld Plate

Purpose

To secure HVAC units mounted on vibration isolators.

Caution
When anchoring to post-tensioned slab, locate and avoid reinforcing.

Recommendation

Install restraint brackets or seismic snubbers.

Supplies Required

- Angle—6" × 6" × 1/2" × 4"
  OR
  Bent plate—3/8"
- Lag bolts—5/8" diameter × 6" (for wood)
- Expansion bolts—5/8" diameter × 4" (for concrete)
- Flex-line
- Steel Z snubbers (or other seismic type snubber)
- 4 × blocking (for wood construction)
- Framing clips (for wood construction)

Installation

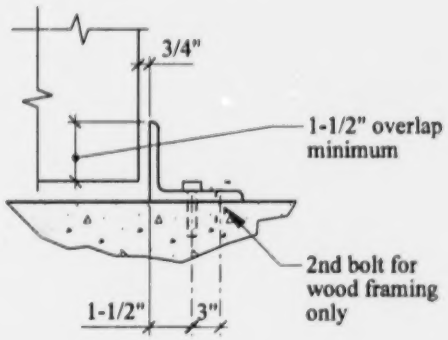
Restrain Bracket Installation

1. Provide two angles or bent plates at each corner of the unit.
2. Bolt to support with one bolt per angle. (For wood use (twp lag bolts at 3" spacing per angle.)

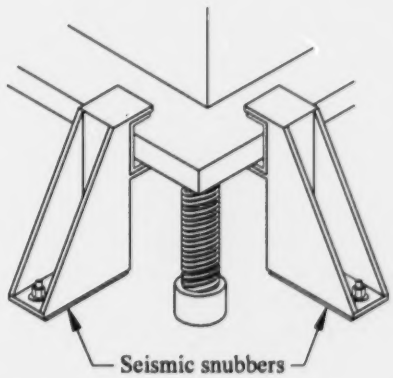
Seismic Snubber Installation

1. Provide two snubbers at each corner of the unit.
2. Bolt to support, providing sufficient free play to allow unit vibration under normal use.

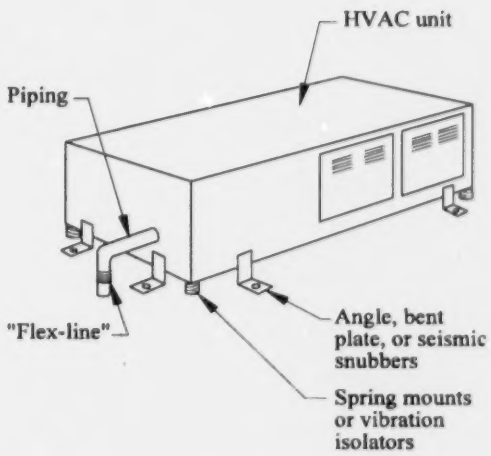
Note
Provide Flex-line at piping (see Section 9.6).



Restraint Bracket



Seismic Snubbers



HVAC Unit

Purpose

To secure unit or duct to roof.

Recommendation

Install metal straps; brace unit supports

Supplies Required

- Metal straps (18 gage × 2")
- Sheet metal screws—No. 10 × 3/4"
- Angle—1-1/2" × 1-1/2" × 1/4"

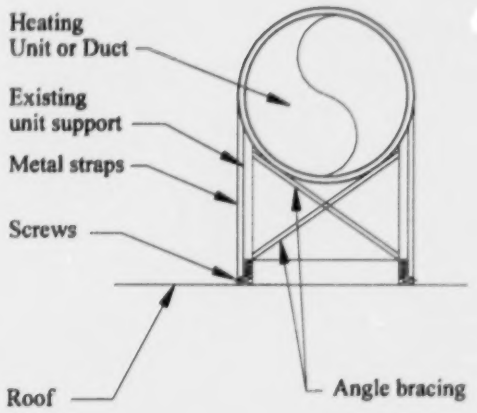
Installation

To attach metal straps to the unit or duct, follow these steps:

1. Wrap metal straps around heating/duct unit at each support location.
2. Attach metal strap to existing supports of the unit with screws.

To brace the unit or duct to the roof and strengthen the existing supporting, follow this step:

Weld or screw top and bottom of the angles to the existing supports.



Rooftop Heating Unit Or Duct With Metal Straps

Purpose

To secure rooftop mechanical units.

Caution
When anchoring to post-tensioned slab, locate and avoid reinforcing.

Recommendation

Install clips and blocking.

Supplies Required

- Clips, *Z* and *L*—1/8" thick
- Lag bolts—3/8" diameter (for wood)
- Sheet metal screws—No. 10 × 3/4" (for steel)
- 4x blocking (for wood)
- Blocking—L2 × 2 × 3/8" (for steel)
- Drive pins
- Framing clips (for wood) Simpson A35

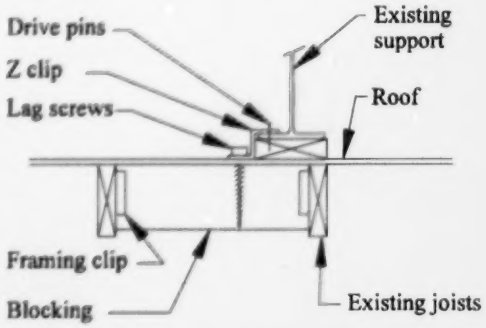
Installation

To install blocking and clips for a wood roof, follow these steps:

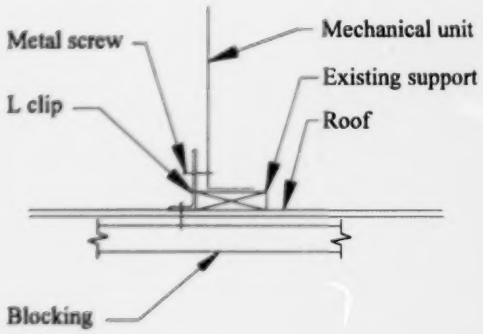
1. Insert 4x blocking between existing joists with framing clips
2. Attach *Z* or *L* clip to mechanical unit with corresponding fasteners and attach to blocking. Place clips at 24" on center minimum.
3. Patch roof as required.

To install blocking and clips for a steel roof, follow these steps:

1. Insert blocking between existing joists and weld in place.
2. Attach *Z* or *L* clip as mechanical unit with corresponding fasteners and attach to blocking. Position clips at 24" on center minimum.
3. Patch roof as required.



Mechanical Units With Blocking And Clips On A Wood Roof



Mechanical Units With Blocking And Clips On A Steel Roof

Purpose

To secure suspended air conditioning units.

Caution
When anchoring to post-tensioned slab, locate and avoid reinforcing.

Recommendation

Strengthen the existing supports with angle brace.

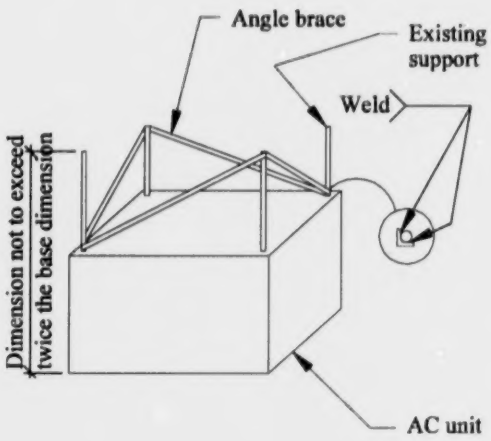
Supplies Required

- Angle—1-1/2" × 1-1/2" × 1/4"
- U-bolts—1/4" (if applicable at piping) (see Section 9.6)
- Sheet metal screws—No. 10 × 3/4"

Installation

1. Brace air conditioning (AC) unit with angles, installed diagonally at every other or on alternate sides.
   OR
   Weld angle bases to support rod.
2. Screw top and bottom of each angle to the supports with sheet metal screws.

Note
■ If the space between the ceiling and the bottom of any unit exceeds twice the minimum base dimension, move heater up so that space is less than two times the base dimension. **OR** Brace the unit to the side wall if the unit cannot be moved up. Build a support frame for the heater with diagonal braces. ■ Consult a structural engineer for bracing design for other conditions.



Suspended Air Conditioning Unit Braced With Angle

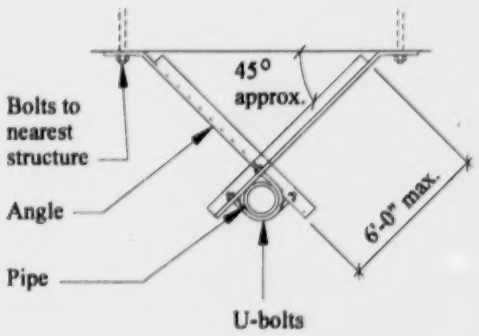
Purpose

To secure piping.

Caution
Secure ALL pipes that are used for fire protection systems. When anchoring to post-tensioned slab, locate and avoid reinforcing.

Recommendation

Install pipe brackets as indicated in the following figures:



Pipe Bracket

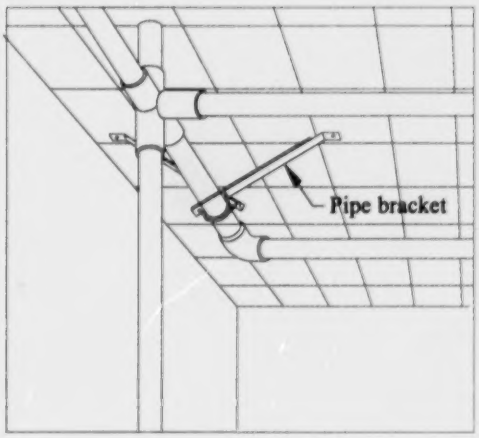
Supplies Required

- Angle—2" × 2" × 1/8"
- Lag bolts—1/4" diameter × 3" (for wood)
- Expansion bolts—3/8" diameter (for concrete)
- U-bolts—1/4" diameter (for concrete)
- Flexible connections to equipment

Installation

1. Install angle braces (cope as required) with lag bolts into wood joists,
   OR
   expansion bolts to concrete.
2. Attach each angle brace to the pipe with a U-bolt.
3. Locate at 90° turns in pipe where the pipe is continuous.
4. Place bracing brackets at 16' on center along unbraced runs of straight pipe.
5. Add flexible connections.

Note
■ Brace fuel, oil, gas, or compressed air pipes that are greater than 1" in diameter. ■ Do not use pipes to support other pipes. ■ Wall openings for the pipe sleeves must be at least 2" larger than the pipe in fire-resistant systems. Consult a building official for the proper fill material in the wall gap.



Typical Piping

Purpose

To secure water heaters.

Caution
When anchoring to post-tensioned slab, locate and avoid reinforcing.

Recommendation

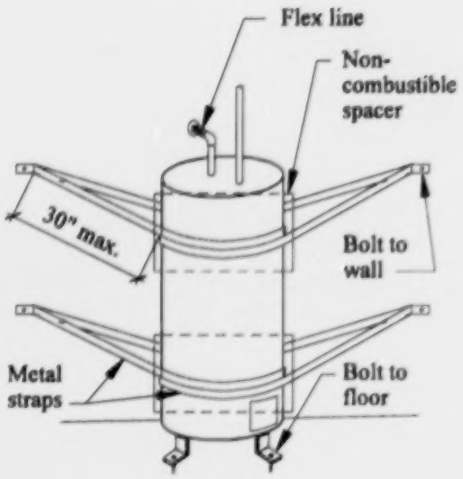
Anchor a heater to the wall with straps and bolt the heater legs to the floor.

Supplies Required

- Noncombustible spacer
- Metal strap (or plumbers tape)—20 gage × 1"
- Expansion bolts—3/8" diameter (for concrete)
- Lag bolts with washers—5/16" × 3" (for wood)
- Flex line
- Angle—3" × 3" × 1/4"
- Machine bolts—3/8"

Installation

1. Place a noncombustible spacer between heater and the wall.
2. Wrap metal straps, two at the top and two at the bottom, around the heater, and anchor both ends of each strap together to the wall structure with bolts. (Do not attach the straps to gypsum wallboard only.)
3. Attach water heater legs to the floor as directed in Section 6.3.
4. Provide *flex line* in rigid water lines to avoid disruption of water service and water damage.
5. Install flexible gas line connections, if applicable.



Water Heater

Purpose

To brace suspended ceilings.

Recommendations

- Provide splay brace wires and compression struts.
- Separate the edges of suspended ceilings from enclosing walls.
- Secure lay-in tiles and boards used in ceiling grids with clips at exitways and corridors.

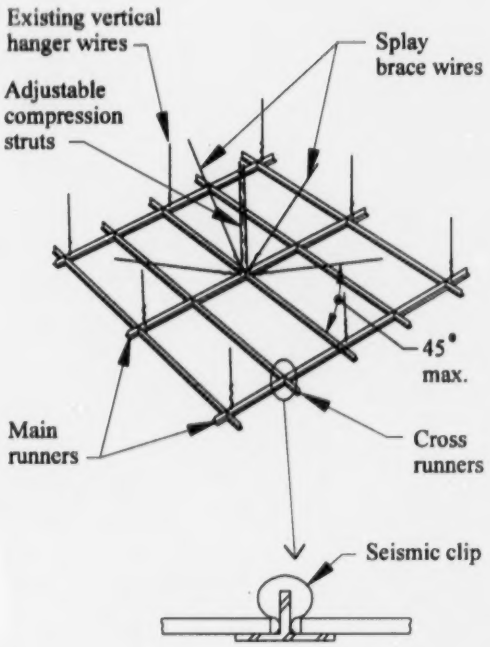
Supplies Required

- Wire—No. 12 gage
- Adjustable compression struts
- Ceiling panel clips

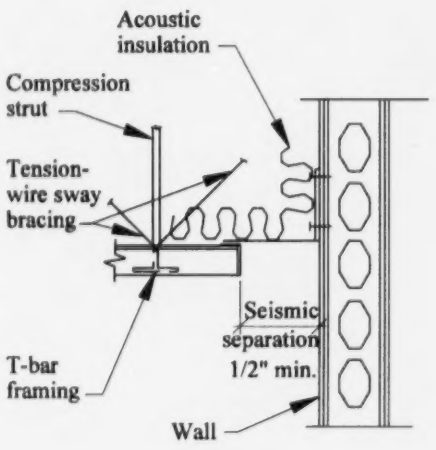
Installation

1. Install splayed wires at 12' on center in four directions.
2. Provide adjustable compression struts, at center of splayed wires, and attach to the structure above.
3. Provide ceiling tile clips at exits and stairwells.
4. Provide 1/2" minimum separation between the ceiling system and the enclosing walls.

Note
■ For installing ceiling bracing in concrete and steel buildings refer to Section 10.2. ■ For installing ceiling bracing in wood buildings refer to Section 10.3.



Typical Ceiling Grid



Seismic Separation Around Suspended Ceiling

Purpose

To brace suspended ceilings in concrete and steel buildings.

Caution
When anchoring to post-tensioned slab, locate and avoid reinforcing.

Recommendation

Provide splay wires and compression struts.

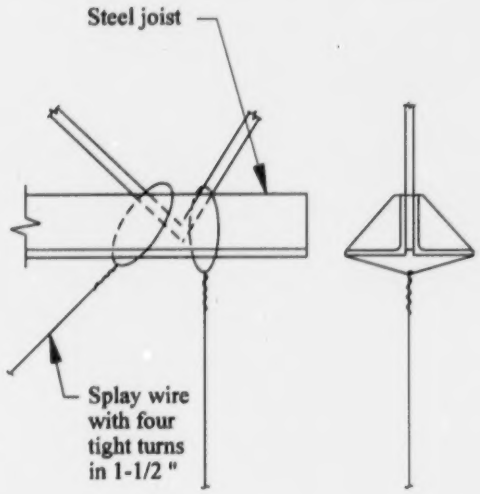
Supplies Required

- Wire—No. 12 gage
- Adjustable compression struts
- Eye-bolts with expansion inserts—3/8" diameter

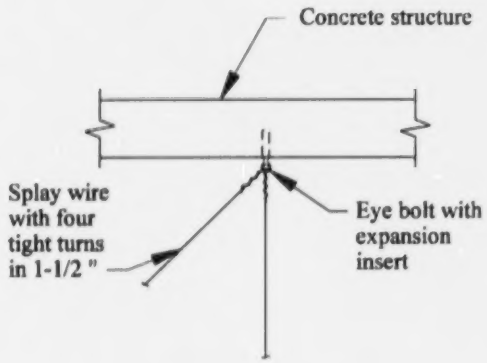
Installation

1. Install splay wires at 12' on center in four directions (See Section 10.1 for layout).
2. Attach adjustable compression struts, placed at the center of the splayed wires, to the structure above.

Note
■ Secure lay-in tiles or boards in ceiling grids, located at exitways and corridors, with clips. See Section 10.1. ■ Provide 1/2" minimum separation between the ceiling system and enclosing walls. See Section 10.1.



Ceiling Supported By Steel Framing



Ceiling Supported By Concrete Framing

Purpose

To brace suspended ceilings in wood buildings.

Recommendation

Provide splay wires and compression struts.

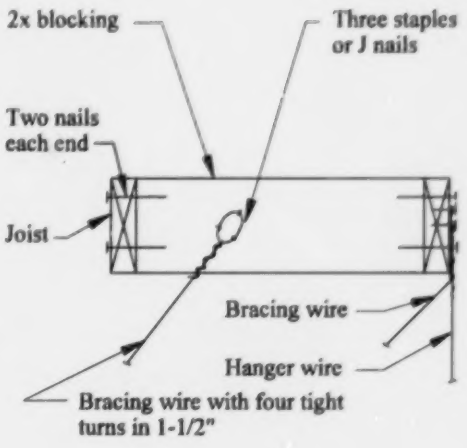
Supplies Required

- Wire—No. 12 gage
- Staples—No. 9 gage, 1-1/2"
  OR
- Stronghold J nails
- Eye-screws—1/4" diameter
- Nails—16 penny common
- 2x blocking
- Adjustable compression struts

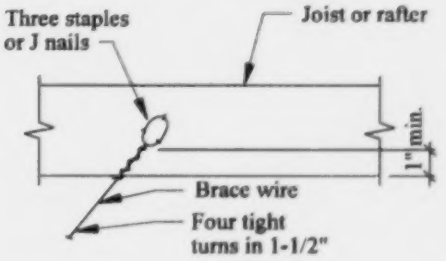
Installation

1. Install splay wires at 12' on center in four directions with staples, J nails, or eye-screws (see Section 10.1 for layout).
2. Install 2x blocking between joists with common nails, where required for the attachment of splayed wires.
3. Provide adjustable compression struts, at center of splayed wires, to the structure above (see Section 10.1).

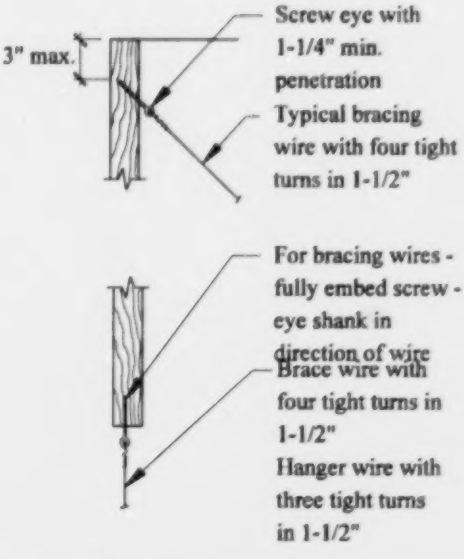
Note
■ Secure lay-in tiles or boards in ceiling grids at exitways and in corridors with clips. (See Section 10.1.)
■ Provide 1/2" minimum separation between the ceiling system and enclosing walls. See Section 10.1.



Wire to Blocking



Wire To Joists


3" max.
Screw eye with 1-1/4" min. penetration
Typical bracing wire with four tight turns in 1-1/2"
For bracing wires - fully embed screw - eye shank in direction of wire
Brace wire with four tight turns in 1-1/2"
Hanger wire with three tight turns in 1-1/2"

Wire To Joists With Eye Screws

Purpose

To secure lights and grills.

Recommendation

Brace lights with wire.

Supplies Required

- Wire—No. 12 gage

Installation

Wire

1. Brace ceiling-mounted lights with a diagonal wire at each corner to the structure above.
2. Secure wire with three tight turns at each end.

Note
■ Replace diffuser panels with plastic panels. ■ Add safety chains to panels if these are lacking.

Recommendation

Install slips to secure ventilation grills.

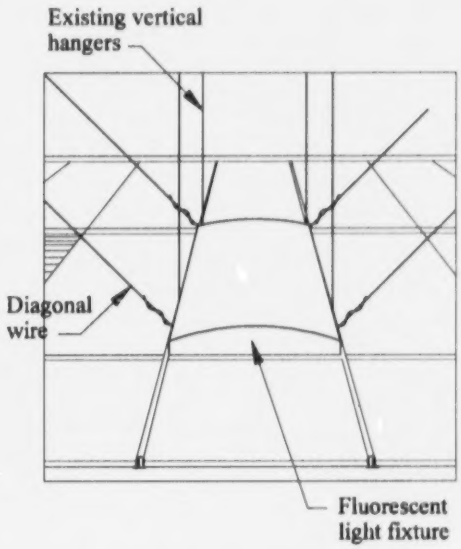
Supplies Required

- Clip—18 gage
- Sheet metal screws—No. 6

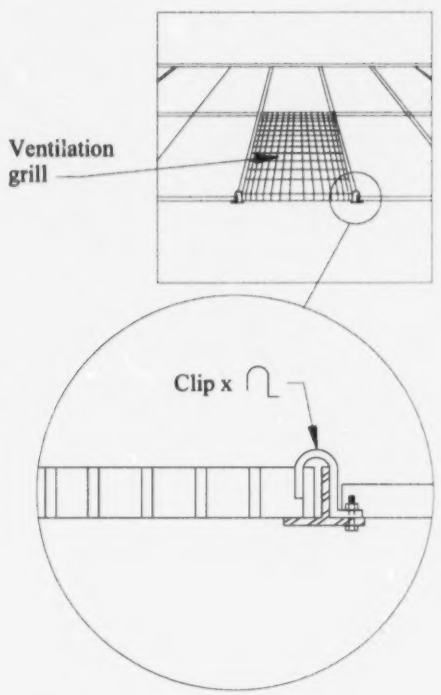
Installation

Clip Installation

1. Install one clip at each corner of the grill.
2. Attach the clip to T-grid with one screw.



Ceiling-Mounted Lights



Ventilation Grill

Purpose

To secure pendant-mounted lights or double-hung fluorescent lights.

Note
■ Replace glass globes with unbreakable substitutes. ■ Vertical support for the light should consist of wire, alongside cord, to the structure above.

Recommendation

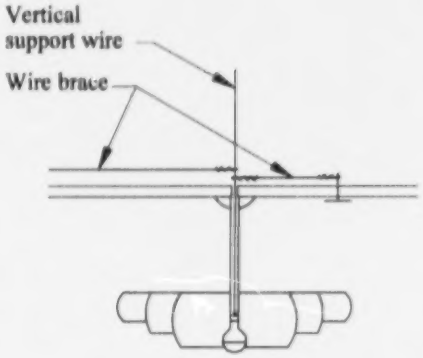
Brace vertical lamp support to the adjacent ceiling structure.

Supplies Required

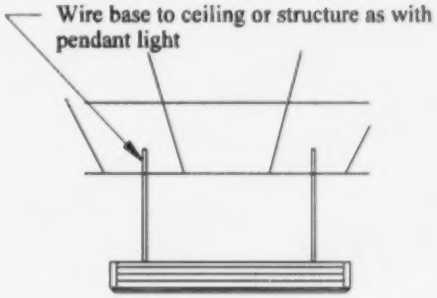
- Wire—No. 12 gage

Installation

1. Brace the vertical lamp support with wire to theadjacent ceiling grid in three directions.
2. Secure the wire brace with three tight turns at each end.



Pendant-Mounted Light



Double-Hung Fluorescent Light

Purpose

To brace ducts.

Recommendation

Provide transverse and longitudinal bracing in accordance with the SMACNA Seismic Restraint Manual Guidelines for Mechanical Systems.

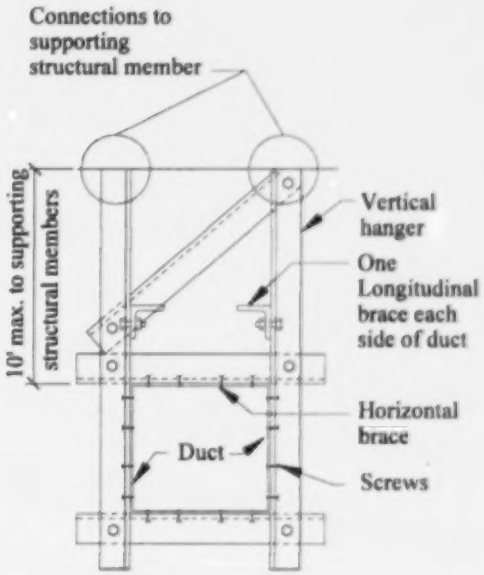
Supplies Required

- Steel angles—size varies with ducts
- Machine bolts—1/2" diameter
- Sheet metal screws—No. 10

Installation

1. Provide angle braces sized in accordance with the SMACNA guidelines. Attach together with machine bolts. Maximum spacing is 40' for transverse bracing and 80' for longitudinal bracing.
2. Provide screws at 18" on center maximum from the bracing to the duct.
3. Attach bracing to the structure above in accordance with the SMACNA guidelines.

Note
■ Bracing is required at ducts exceeding 6 square feet in cross-sectional areas, and for round ducts exceeding 28" in diameter. ■ No bracing is required if the top of the duct is 12" or less from the support above. See SMACNA guidelines for hanger requirements. ■ Walls, through which ducts pass, can be substituted for transverse braces. Provide blocking around the duct.



Duct Bracing

Purpose

To brace the space heaters.

Recommendation

Install angles and flexible pipe connections.

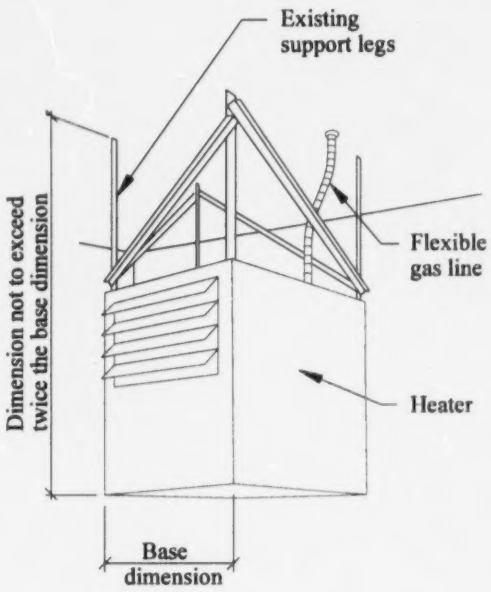
Supplies Required

- Angle—1-1/2" × 1-1/2" × 1/8"
- U-bolts—if applicable (see Section 9.6)
- Flexible gas line—if applicable
- Sheet metal screws—No. 10

Installation

1. Brace the space heater with angles that are installed diagonally on each side.
2. Screw top and bottom of the angle to existing support legs or weld them together (See Section 9.5).
3. Install flexible gas pipe connections, if applicable.

Note
■ If the space between the ceiling and the bottom of any space heater exceeds twice the minimum base dimension, move the heater up so that the space is less than two times the base dimension. **OR** Brace the heater to the side wall if the space heater cannot be moved up. Build a support frame for the heater with diagonal braces. ■ Consult a structural engineer for bracing design for other conditions.



Space Heater

Purpose

To brace partitions that extend to the ceiling.

Caution
When anchoring to post-tensioned slab, locate and avoid reinforcing.

Recommendation

Install braces that extend to the structure above.

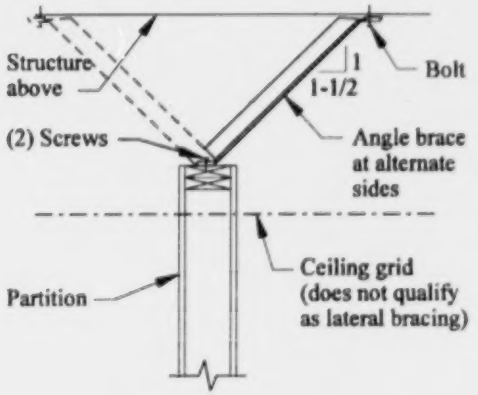
Supplies Required

- Angle—2" × 2" × 1/8" (for bracing over 10" in length, use 3" × 3" × 3/16")
- Expansion bolts—3/8" diameter (for concrete)
- Lag bolts—3/8" diameter × 3" (for wood)
- Screws—No. 12

Installation

1. Install angle braces at 8'-0" on center, alternating sides, at least two per partition.
2. Attach the angle to the structure above with expansion bolts for concrete or lag bolts for wood.
3. Attach the angle to the top plate of the wall with two screws.

Note
Provide 1/2" minimum separation between the ceiling system and enclosing walls (see Section 10.1).



Full Height Wall Section

Purpose

To secure masonry partitions.

Recommendation

Install braces to the structure above.

Supplies Required

- Clip angles—3" × 4" × 1/4" × 1'-3"
- Expansion bolts—1/2" diameter (for concrete)
- Channel (appropriate for wall width)
- Angles—4" × 4" × 1/4"
- Angles—3" × 3" × 1/4"
- Drive pins—5/32" diameter (for steel)
- Lag bolts—3/8" diameter × 3" (for wood)
- Wood blocking—4x
- Framing clips—Simpson A35

Installation

Concrete Building Installation

1. Weld 3" angle braces at 4'-0" on center to continuous channel over wall.
   OR
   Install clip angles at 4'-0" on center each side of the wall.
2. Attach the angles to the structure above with expansion bolts. Use two bolts for each clip angle.

Steel Building Installation

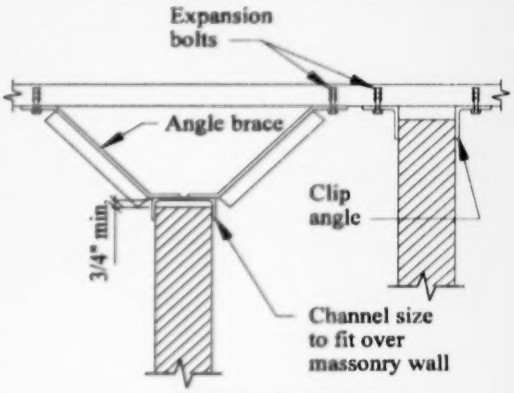
1. Install 3" angle braces at 4'-0" on center.
2. Attach angle to the structure with drive-pins.
3. Weld continuous 4" angle on each side of the partition to 3" angles.

Wood Building Installation

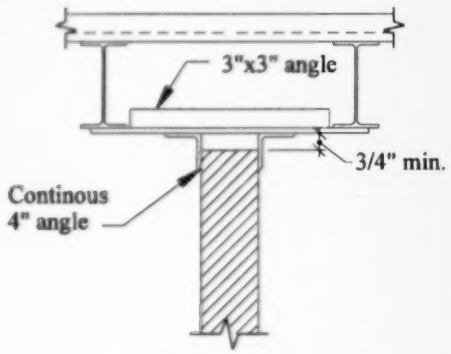
1. Position 4x blocking between joists with framing clips.
2. Install continuous 4" angle on each side of the wall.
3. Attach angles to new 4x blocking with lag bolts at 4'-0" on center.

Caution

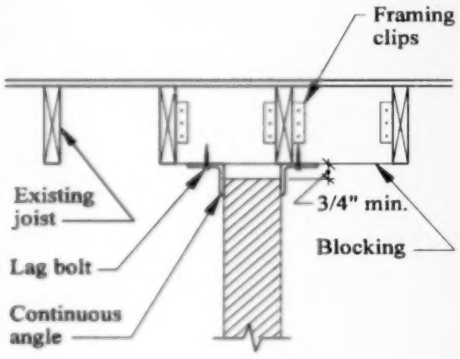
- Unreinforced masonry partitions are extremely hazardous and should be removed if possible.
- When anchoring to post-tensioned slab, locate and avoid reinforcing.



Concrete Structure



Steel Structure



Wood Structure

Purpose

To secure modular partitions.

Recommendation

Arrange multiple partitions in a zigzag or tee-shape fashion. Install restraints to single modular partitions.

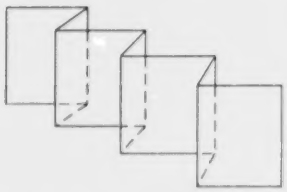
Supplies Required

- Angles—3" × 3" × 1/4"
- Expansion bolts—3/8" diameter (for concrete)
- Lag bolts—3/8" diameter (for wood)
- Thru-bolts

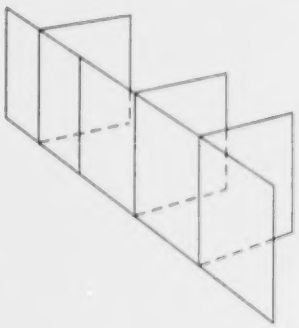
Installation

1. Install angle braces at each end on each side of the partition with thru-bolts.
2. Attach the angles (or partition feet) to the floor with expansion bolts for concrete or lag bolts for wood.
   OR
   Anchor the partition to the adjacent desk.

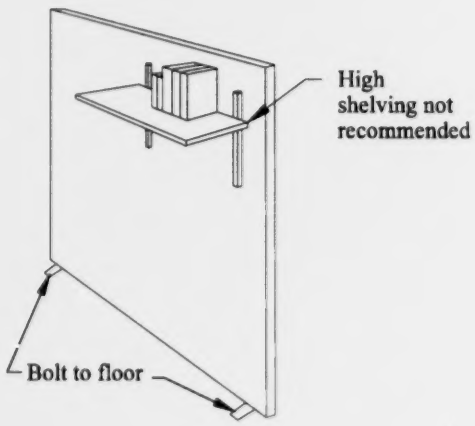
Caution
When anchoring to post-tensioned slab, locate and avoid reinforcing.



Zig-Zag Partition Arrangement



Tee-Shape Partition Arrangement



Single Partition

REFERENCES

Federal Emergency Management Agency. 1994. *Reducing the Risks of Nonstructural Earthquake Damage. A Practical Guide.* (FEMA 74). Prepared by Wiss, Janney, Elstner Associates, Inc., third edition, Washington, D.C.: FEMA.

Dames & Moore. 1994. *The Northridge Earthquake; January 17, 1994.* A Special Report by Dames & Moore. Los Angeles, California.

Gonan, Behram and N.M. Hawkins. 1974. *Building Standards and the Earthquake Hazard for the Puget SoundBbasin.* University of Washington Department of Civil engineering Report SM 74-1. Seattle, Washington.

Hall, John F. 1994. *Northridge Earthquake; January 17, 1994; Preliminary Reconnaissance Report.* Earthquake Engineering Research Institue 94-01. Oakland, California.

Noson, Linda Lawrance, Anthony Qamar, and Gerald W. Thorsen. 1988. *Washington State Earthquake Hazards.* Washington Division of Geology and Earth Resources Information Circular 85. Olympia, Washington.

Noson, Linda Lawrance and Todd W. Perbix. 1989. *Safer Schools: Earthquake Hazards, Nonstructural.* Washington Superintendent of Public Instruction. Olympia, Washington.

Noson, Linda Lawrance. 1999. *Home Retrofit Information Series: Booklet 1, Booklet 2, Booklet 3.* Department of Construction and Landuse. City of Seattle, Washington.

Perbix, Todd W. and Linda Lawrance Noson. 1996. *B. F. Day Elementary School Seattle. A Publication Series on Applied Seismic Design of Buildings. Design Decisions, Methods, and Procedures.* Earthquake Engineering Research Institute. Oakland, California.

Thorsen, G.W., compiler. 1986. *The Puget Lowland Earthquakes of 1949 and 1965- Reproductions of selected articles describing damage.* Washington Division of Geology and Earth Resources Information Circular 81, 113p. Olympia, Washington.

Wood, H. O., Neumann, Frank. 1931. *Modified Mercalli Intensity Scale of 1931.* Seismological Society of American Bulletin, v.21, no. 4, p. 277-283.

VENDOR LIST

Vendor/Address	Phone/Fax/Email/Web	Contact	Product
ArmorCoat of Washington 956 Industry Drive Seattle, WA 98188	Phone 206-575-4777 Fax: no fax		Glass films
C.M. Hoskins Co., Inc. 7353 15th NW Seattle, WA 98117-5498	Phone: 206-789-1600 Fax: 206-789-1604		Variety of fastening products
Earthquake Preparedness Society 7981 168th Avenue NE Redmond, WA 98052	Phone: 425-556-0911 Fax: 425-556-0734		Variety of fastening products
Earthquake Safety Systems 7716 Balboa Avenue Van Nuys, CA 91406	Phone: 818-501-0628 Fax: 818-781-3223 www.earthquakeservices.com		Gas
Earthquake Services Corporation 1670 Alvarado Street, Suite 14 San Leandro, CA 94577	Phone: 800-890-8566 Phone: 510-987-3907 Fax: 510-352-2415	Jerry Florence	Specializes in commercial
Fastening Solutions, Inc. 15236 Burbank Boulevard, Suite 101 Van Nuys, CA 91411	Phone: 818-994-6398 Fax: 818-997-1371		Thumb locks (CMHoskins local distributor)
Quake Defense, Inc. 861 Hinckley Road Burlingame, CA 94010	Phone: Fax:		Gas shut-offs
Real Enterprising 5530 Weber Road Vacaville, CA 95687	Phone: 916-678-5638 Fax:		Seismic shelf guard
Spacesaver 819 Industry Drive, Building 19 Seattle, WA 98188	Phone: 206-575-1460 Fax:	Steve Englung	Mobile storage and filing systems
Strand Earthquake Consultants 1436 Bentley Avenue, #6 Los Angeles, CA 90052	Phone: 213-473-2316	Carl Strand	Generators, gas shut-offs
STRS (Safe-T-Rack Systems) 325 Dominguez Road, Suite A Rocklin, CA 95677	Phone: 800-344-0619 Phone: 916-632-1121 Fax: 916-632-1173		Gas cylinders (Strand local distributor)
Taylor Electric Supply 1709 SE Third Avenue Portland, OR 97214	Phone: 501-233-5321 Fax:		Electrical supply
TERRA Technology Corporation Redmond, WA	Phone: Fax:		Toxic gas seismic trigger (Strand)
WorkSafe Northwest 17315 N.E. 42nd Street Redmond, WA 98052	Phone: 425-556-0911 Fax: 425-556-0734		Seismic Protection Services

DRAFT LIST OF DISTRICT MANAGER ACCESS DATABASE TABLES

Item	Description
1	School location table (name of school, address, city, state, zip code)
2	Occupant information (type of school—elementary, middle, high school; number of students, number of staff)
3	Building information table (type of construction, age, square footage, number of floors, irregular plan, irregular elevation) This is difficult because each school will have many buildings and many additions to each building.
4	Nonstructural element inventory (location, name of element, quantity, cost to correct, vendors(?), expertise, permits)
5	Nonstructural priority table?
6	Opportunity table (what elements can be done when other work is scheduled)

SCHOOL FACILITIES MANUAL
Nonstructural Protection Guide

SECTION D

APPENDICES

APPENDIX D-1

REFERENCES CITED

Federal Emergency Management Agency. 1994. *Reducing the Risks of Nonstructural Earthquake Damage: A Practical Guide*. FEMA 74.

Gonen, Behram and Neil M. Hawkins. 1974. *Building Standards and the Earthquake Hazard for the Puget Sound Basin*. Report SM 72-1. University of Washington. College of engineering. Department of Civil engineering. Seattle, Washington.

Noson, Linda Lawrance, Qamar, Anthony and Gerald Thorsen. 1988. *Washington State Earthquake Hazards*. Washington Division of Geology and Earth Resources. Information Circular 85.

Office of the Superintendent of Public Instruction. School Facilities Manual. Supercedes the Third Edition of the School Facilities Development Procedures Manual published in 1990. Available to download from: http://ospiwsrv.ospi.wednet.edu/schoolbldg/sfmchap1.htm

Perbix, Todd W. and Linda L. Noson. 1996. *B.F. Day Elementary School*. A Publication Series on Applied Seismic Design of Buildings. Earthquake Engineering Research Institute. Oakland, California.

Reitherman, Robert. 1996. Nonstructural Damage – Slide Set. Issued by Earthquake Engineering Research Institute. 499 14th Street, Suite 320, Oakland, California 94612-1934.

Thorsen, G.W., compiler. 1986. *The Puget Lowland earthquakes of 1949 and 1965 – Reproductions of selected articles describing damage*. Washington Division of Geology and Earth Resources information Circular 81. 113p.

Wood, H. O. and Frank Neumann. 1931. *Modified Mercalli Intensity Scale of 1931*. Seismological Society of America Bulletin. V.21. no. 4. P. 277-283.

US Department of Commerce. 1950. *Abstracts of Earthquake Reports for the Pacific Coast and the Western Mountain Region: April, May, June 1949*. Issued by the US Coast and Geodetic Survey. Washington, D.C.

The following references were used in compiling the checklists, details, and installation notes and are not cited specifically in the text:

Checklist of Nonstructural Earthquake Hazards. Sacramento: California Office of Emergency Services Earthquake Project.

McGavin, Gary L. 1981. Earthquake Protection of Essential Building Equipment: Design, Engineering, Installation. New York: John Wiley & Sons. Many nonstructural details originated with the work included in this book. Specialized equipment inventories, such as critical hospital equipment, are also included.

Pacific Rim Seismic Safety Inc. 1989. Non-Structural Earthquake Hazard Reduction Survey. 607-402 West Pender Street. Vancouver, B.C. V6B1T6.

Reitherman, Robert. 1991. *Nonstructural Earthquake Protection Manual for Idaho Schools.*. Boise: Idaho Bureau of Disaster Services. An excellent document for schools. Includes sections on purchasing criteria and school policies.

APPENDIX D-2

VENDORS

Vendor Name	Address	Product
ArmorCoat of Washington	956 Industry Drive Seattle, WA 98188	Glass films
C.M. Hoskins Co., Inc.	7353 15th NW Seattle, WA 98117-5498	Variety of fastening products
Earthquake Preparedness Society	7981 168th Ave. NE Redmond, WA 98052	Variety of fastening products
Earthquake Services Corporation www.earthquakeservices.com	1670 Alvarado St. Suite 14 San Leandro, CA 94577	Specializes in commercial products
Fastening Solutions, Inc.	15236 Burbank Blvd. Suite 101 Van Nuys, CA 91411	Thumb locks (CM Hoskins distributes this product locally)
Quake Defense, Inc.	861 Hinckley Road Burlingame, CA 94010	Gas Shut-off valves
SafeScape Evacuation Ltd.	765 Powell St. Vancouver, BC V6A1H5	Evacuation Lights
Spacesaver	819 Industry Drive Bldg. 19 Seattle, Wa 98188	Movile storage & filing systems
Strand Earthquake Consultants	1436 Bentley Ave. #6 Los Angeles, CA 90025	Generators. Gas shut-off valves
STRS (Safe-T-Rack Systems)	325 Dominguez Rd. Suite A Rocklin, Ca 95677	Gas cylinders (Strand local distributer)
Taylor Electric Supply	1709 SE third Ave. Portland, OR 97214	Electrical Supply
WorkSafeTechnologies www.worksafetech.com	17315 NE 42nd St. Redmond, WA 98052	Variety of fastening products
This list is based upon information collected at earthquake conferences and from checking the yellow pages under "Earthquake Services & Supplies". It is not an endorsement of the companies or products. Often supplies can be obtained from hardware stores or on-hand materials. Any material substitutions must be capable of resisting comparable loads. No attempt was made to identify all suppliers. .		

APPENDIX D-3

SEATTLE PROJECT IMPACT PILOT TEST
Seattle Public Schools Nonstructural Protection Program

INTRODUCTION

Seattle Project Impact is a public/private partnership initiated by the Federal Emergency Management Agency (FEMA). FEMA's Project Impact program is a community response, focusing the efforts of homeowners, government, businesses, educators, community groups, and volunteers on one goal: a safer community. Through the leadership of Seattle Emergency Management and extensive participation and in-kind contributions from many private and public organizations, Seattle Project Impact has generated a collaborative approach to managing the impacts of natural hazards to buildings and systems in the Seattle area.

The Seattle Project Impact organizing committee identified three priority projects for improving community disaster resistance: earthquake home retrofit, school earthquake safety, and the improved delineation and evaluation of seismic and landslide hazards. Monthly committee meetings provide an opportunity to monitor progress, keep community partners informed, and identify new projects.

SEATTLE PUBLIC SCHOOLS

The Seattle Public Schools focused their effort on improving school earthquake safety by reducing the potential for earthquake-induced damage to the nonstructural elements of school buildings. This project is a natural continuation of the district's Capital Improvement Program to strengthen district buildings to resist earthquake-induced structural damage. Notable earthquakes in 1949 and 1965 caused a disproportionate amount of damage to Seattle school buildings. Extensive repairs and building replacements were required to fix the damage caused by these two events. Subsequent seismic evaluations and retrofit of Seattle schools began in 1977. Since the structural retrofit of school buildings is near completion, the district can not focus greater attention to the reduction of nonstructural earthquake hazards.

The Seattle Public Schools Project Impact program includes: (1) removing overhead safety hazards; (2) evaluating automatic seismic gas shut-off valves; and (3) updating the 1988 School Earthquake Hazard Reduction Manual and (4) implementing a District nonstructural mitigation program. Funding for these activities combined $400,000 from FEMA through Seattle Project Impact, $100,000 from the Seattle Public Schools and in-kind contributions by district staff, volunteers and Project Impact partners.

(1) Removing Overhead Hazards

Many Seattle schools have out-dated waste water systems. Heavy reservoirs of water located in school attics (Figure 1) and porcelain tanks of water located in boy's restrooms are part of these antiquated systems. These nonstructural elements are particularly vulnerable to earthquake-induced damage. The consequences of failure pose significant life safety hazards to building occupants. The water in five reservoir vats was drained. Porcelain tanks were removed and high-pressure flush systems were installed in 46 Seattle school buildings. Labor and materials required to remove these hazards amounted to nearly $235,000. Two-thirds of this cost was for labor. The removal took approximately 4,000 hours.

Figure 1. Outdated water reservoir located in an attic.

(2) Evaluating the Advisability of Installing Automatic Gas Shut-Off Valves

Extensive discussions occurred between the District and the local gas service provider (Puget Sound Energy) concerning the advisability of installing earthquake activated automatic gas shut-off valves (Figure 2) on school gas lines. A survey of gas service providers in California (Pacific Gas & Electric and Southern California Gas Companies) and Idaho Power identified conflicting company policies. In Los Angeles, shut-off valves are required on new residential construction and on remodels that cost over $10,000. However, in most areas the decision to install a gas

automatic shut-off valve is left up to the customer. The valves are installed on the customer's side of the gas meter and may require a plumbing permit. Valves must be firmly attached to the building or it's foundation and located in a protected, secure area, away from foot or vehicle traffic. A school with a large

Figure 2. Automatic gas shut-off valve

distribution system may require a number of shut-off valves to adequately restrict potential gas leaks. Maintenance of the valves is the school district's responsibility.

Gas service providers stressed that there are more cost effective actions to improve gas safety, including bracing gas water heaters, installing flexible pipe connections to water heaters, stoves, furnaces, and other gas appliances, and reviewing the age, type and distribution of gas piping to identify potential hazards. The decision to install automatic gas shut-off valves must be made on a case by case basis.

The Seattle School District installed three valves, one at a high school and two at a middle school for a cost of $9200 (Figure 2). A number of factors were considered in the initial decision to install the automatic gas shut-off valves. For example, high schools and middle schools have gas hazards in laboratories and shop areas; a number of school buildings have older, more vulnerable gas distribution systems; and, a leak could go unnoticed if an earthquake occurred when school was not occupied. However, valve installation was discontinued. The district decided that due to the high costs of installation nonstructural hazard reduction funds would be better applied to other protective measures. Seattle's frequent cool, damp weather also raised concern about the comfort and safety of students in classrooms if gas fueled heaters were shut off. Further,

recovery of the school education program might be delayed if classrooms were unheated. The installation of automatic gas shut-off valves is a low priority protective measure for the Seattle School District.

If gas service is shut off following a major earthquake, either automatically or manually, the service provider must be notified to restore service. The customer should not attempt to restore service before the system has been evaluated, including having the gas pipes pressurized to determine if leaks in the system do exist. Service restoration may take days to weeks. To avoid lengthy, unnecessary service outages, which may result in school closure, avoid shutting-off gas service unless there is evidence that a leak is present.

If the building lacks an automatic gas shut-off valve, a strong gas smell will alert building occupants to the presence of a pipe leak. Then the gas service should be turned-off and the building ventilated. If possible, a building that is unoccupied as a result of severe damage should have the utilities – gas, water, and electric – shut-off at the building to avoid damage that may occur when community systems are restored to the damaged area.

(3) Up Date of The Nonstructural Earthquake Hazard Reduction Manual

Updating the Nonstructural Guide

Background

The *Nonstructural Protection Guide* is an update of the School Earthquake Hazard Reduction Manual. The earthquake hazard reduction manual was published by the Office of the Superintendent of Public Instruction (OSPI) in 1988 and distributed to school districts in western Washington. This revised guide will be a part of the OSPI School Facilities Manual.

The title was revised to enable the information to be incorporated into a comprehensive nonstructural protection program. Protection of nonstructural elements from a variety of potential hazards will be part of the Seattle School District maintenance, risk management, and custodial programs.

Recommended Changes

The guide was updated to include the following sections: (a) past earthquake damage to Washington schools, (b) how to manage a school nonstructural protection program; (c) involving District staff; and (d) working with school site teams. In addition, the protective details in Section C were updated to include new strengthening solutions and installation cautions.

Pilot Test

A pilot test of the content and process contained in the guide was carried out to identify the capability of the manual to assist District staff and school site teams in the identification and protection of hazardous nonstructural elements. Based on the pilot

study the guide was further revised to include a simplified inventory checklist and process.

Revising the Inventory Forms

Inventory Form Complexity

School site teams helped assess the inventory process. These teams include teachers, custodians, maintenance, and PTSA members. A review of the forms completed in these trial inventories showed that the number of elements on the forms overwhelmed most site team members and with the responsibility of assessing the quality of existing attachments. For example, the forms in Section B ask if nonstructural elements are securely attached to a stud wall. The quality-of-attachment is difficult to evaluate unless one is familiar with construction practice and can determine what is a stud wall.

The forms were modified to include two levels of inventory based on skill and training. The revised forms are provided at the end of this appendix. Experience, training, and liability issues distinguish the two levels of inventory:

Level 1 – focuses the identification of the type and number of elements in a room. For safety and liability concerns, the Level 1 inventory does not include the use of a ladder, access to mechanical and electrical rooms, or roof areas.

Level 2 – focuses on the identification of the type and number of elements and an assessment of the quality of attachments, such as the attachment of lockers to the wall in hallways. Issues to be addressed include the selection of hardware, the proper installation of anchors and screws, and the quality of the element used for attachment (stud wall, file cabinet, etc.). This inventory may require a ladder, specialized construction skills, safety training, and coverage under worker's compensation. Inventories will normally be completed by maintenance or facility personnel or by district contractors. Site team members may complete Level 2 inventories if they meet qualification criteria defined by the district and are supervised by district personnel.

Inventory Order

The initial order of elements included on the inventory forms in the guide was revised to reflect the simplicity desired by site teams. Elements generally inventoried by Level 1 teams are now presented first. More complex elements generally inventoried by Level 2 teams are placed at the end of the form. The immediate occurrence of elements like overhead ceiling systems, which are not included in a Level 1 inventory, caused many site team members concern and reluctance to complete the form. Reversing the order of elements reduced this reluctance.

Identifying Protective Measures

Good Housekeeping
This option should be stressed more strongly in the guide. Often simple room rearrangement and proper storage will improve classroom safety. Moving heavy items to low shelves, moving file cabinets away from exit ways, and keeping hallways clear will reduce the risk of direct injury and injury related to blocked exit ways. While simple, these steps are a challenge to schools with limited storage. Reminders of the importance of good housekeeping in providing a safe environment are required to encourage and maintain good housekeeping behavior.

Restraints
Section C of the guide provides construction details for the installation of measures to restrain elements to reduce potential injury to building occupants. More complex elements addressed by these details require skilled personnel for implementation. A list of supplies for each protective measure is included in the details as a guide in the development of an appropriate design.

Commercial products may be substituted for some of the supplies recommended in the protective details provided the substitutions offer equivalent protection. In some instances, such as the restraint of refrigerators, commercial products are easier to install. Product companies may be willing to provide discounts on large orders or help complete a model school in the district.

(4) Implementation of the Seattle School District Classroom Mitigation Program: Lessons Learned

Identifying District Support

Program Management
To ensure program success sufficient management is required. This includes a District Manager, a Site Coordinator and a Building Coordinator. The District Manager schedules the implementation of nonstructural protective measures, monitors the program, trains employees, and prepares budget requests for over head hazards. This management position increases sustainability by integrating all program activities with normal maintenance or facilities operations.

A Site Coordinator is an essential part for increasing interest and involvement by school site teams (Figure 3). The Site Coordinator works with site teams to explain why the program is important and to encourage the implementation of nonstructural protection measures. The Site Coordinator works with site team members to identify protective measures that are most compatible with how building spaces are used. Site Teams may be made up of teachers, custodial staff, parents, community volunteers and others interested in improving school earthquake safety. Site Teams usually have a strong

vision of how classrooms and other building spaces should be organized to support their daily operations.

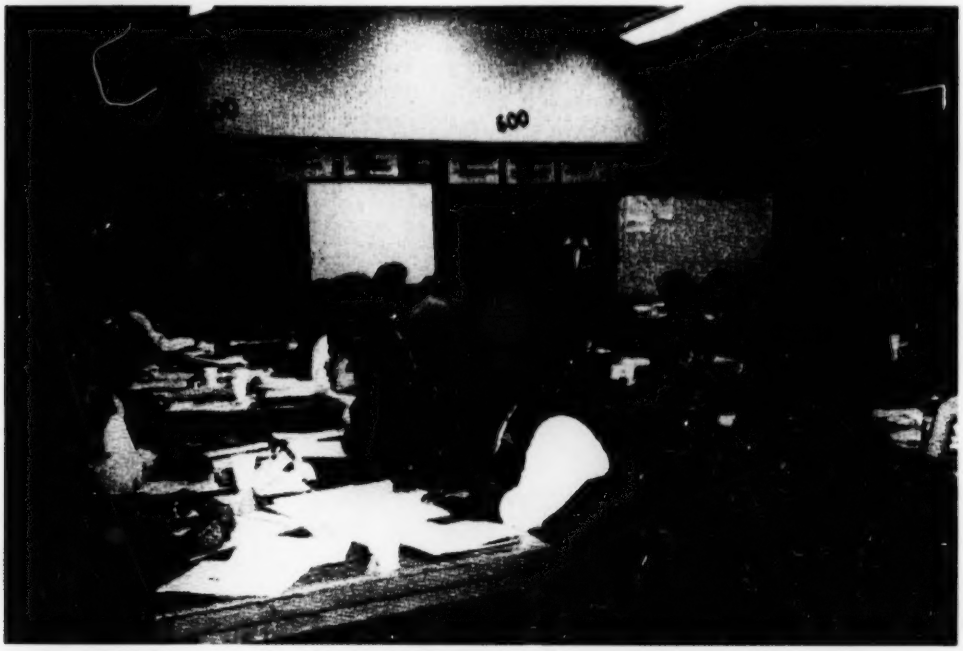
A Building Coordinator (often the Safety Committee Chair or School Nurse) keeps track of work completed at the school. Completed inventory forms are maintained in a binder for review by district safety staff. In Section B, it was originally suggested that these forms be copied and sent to the District Manager. The pilot test indicated it would be easier for the Site Coordinator to check the forms on site.

Training

Training is necessary to provide a consistent approach to the identification and mitigation of nonstructural earthquake hazards and to sustain the program. Maintenance and custodial staff learned how to identify nonstructural elements likely to injure building occupants and how to implement appropriate nonstructural protective measures. The information on protecting nonstructural elements from earthquake-induced damage can be combined with a comprehensive nonstructural protective program that addresses a variety of potential hazards.

District maintenance and custodial staff must be included because of their familiarity with the school buildings, comprehension of basic construction practices, and long term program involvement. Involvement of building staff in identifying and selecting protective measures ensures that solutions are acceptable to building occupants.

Figure 3. Introducing the Seattle School Nonstructural Protection program to teaching staff.



School Participation

Presentations on the program are given at school staff and PTSA meetings. An introductory presentation should be limited to 15 minutes. Brief follow-up meetings can be held to answer questions, identify problem areas, and keep the program moving along. This is also an opportunity to identify individuals willing to participate on the site teams.

Inventorying Building Spaces

District Inventory

A District Core Mitigation Team composed of the Site Coordinator, a Building Custodian, the Maintenance Supervisor, and selected volunteers inventoried a representative sample of school buildings using the revised inventory forms included in this appendix. From this inventory, a standard list of nonstructural items was developed for each building occupancy type. For example, in most Seattle Public Schools a classroom has 1-4 computers, one television set, one VCR, an audiovisual cart with an overhead projector, several bookshelves or wall cabinets, and a file cabinet. A representative inventory of labs, shops, and mechanical rooms in a district provided a common list of items for those spaces. These representative nonstructural elements were entered in an Excel database for each building space. This database was used to estimate type and costs of elements needed for implementing a protective action work plan.

This process provided a consistent approach to the inventory and to the estimation of costs. The Core Mitigation Team included experienced district personnel. District personnel are covered by workman's compensation and participate in district safety programs. In addition, the Core Mitigation Team is best suited to identifying the skills needed to implement protective measures.

The Core Mitigation Team enhances the awareness and participation of school staff at the building level.

Building Site Teams

Site teams, which can include teachers, parents, and other volunteers, may complete the inventory forms included in Section B of the guide or the less complex forms included in this appendix. They may use the inventory to determine the priority of elements that need protection and to estimate costs to implement nonstructural protective measures.

Most site teams will inventory a limited number of elements (Table 1) that are located in selected building spaces and they will implement a limited number of protective measures. A complete inventory and extensive implementation requires training and education in construction practice beyond what is present in most site teams. In addition, there may be legal or union restrictions on using site teams for more than a small part of the nonstructural protection program.

The site teams need to coordinate their nonstructural protection activities with the school district. The building administrator should contact the maintenance manager and, if one

is available, the Site Coordinator. Coordination is important to identify district resources that are available to help individual schools.

Table 1. Inventory tasks and protective actions generally taken by Site Team Members.

Site Team Members: school staff, parents, volunteers, and custodians
Occupancies: Normal, Assembly, and Special Occupancy
Inventory Tasks: Identify the type and number of each element according to school goals and objectives

Types of Nonstructural elements:

- Desktop/counter top equipment
- Furnishings and equipment
- Shelves
- Shelf storage
- Supplies and materials
- AV equipment
- Wall mounted objects
- Maps
- Display Cases
- Location of heavy storage

Protective Actions

- Store heavy objects on lower shelves
- Installation of restraints for desktop/counter-top equipment
- Installation of restraints for shelving under supervision

Implementing Protective Measures

Work Parties

Site teams implemented many of the protective measures. The Core Mitigation Team was essential to the success of the work parties. The core team included a custodian, maintenance crew zone supervisor, and the district site coordinator. This team worked with school staff, parents, and non-profit volunteer agencies (e.g. Habitat for Humanity) to install protective measures appropriate to site team skills. Significant reduction of installation time can be achieved by having enough help to complete the work in one day.

Work Orders

The completed inventory forms are used to prepare work orders for the implementation of nonstructural protective measures that are too complex for work parties. Work orders can only be completed by District staff.

Tools

The District purchased tools and supplies to implement the protective measures (Table 2). Having a set of tools available for this project is essential. The information provided on Table 2 is not an endorsement of specific vendors. Comparison shopping will help identify the best price and quality. Prices are subject to change.

Storage

The Seattle schools initially intended to store the tools and supplies in out-door containers placed on school sites. However, the containers were very cold in the winter. The school buildings provided more comfortable locations from which to access materials. While finding space inside the school buildings was not a problem, the tools needed to be stored in a toolbox to keep them together and easily accessible for work parties.

Table 2 Tools used by the District to implement nonstructural protective measures.

Description	Qty	Stock No.	Vendor	Price Each	Price Ext.
Allen wrench set	3	757-497	Home Depot	$11.97	$35.91
Ballpein hammer	3	342-008	Home Depot	$12.94	$38.82
Claw hammer	3	310-925	Home Depot	$9.47	$28.41
Cord, ext. 25 ft x 12 GA	3	524-646	Home Depot	$15.95	$47.85
Cordless drill, 12Volt	3	190-948	Home Depot	$99.95	$299.85
Crow bar	3	451-010	Home Depot	$5.93	$17.79
Drill index	3	163-486	Home Depot	$19.87	$59.61
Knee pads	3	337-520	Home Depot	$4.98	$14.94
Level Pak	3		Home Depot	$9.84	$29.52
Lockable job box with padlock	3	4824 Knaack	Acme	$265.11	$795.33
Measuring tape; 25 ft	3	Y-125 Lufkin	Home Depot	$6.97	$20.91
Pliers set	3	600-148	Home Depot	$29.96	$89.88
Portable, small vacuum cleaner	3	335-204	Home Depot	$29.96	$89.88
Pry bar, flat	3	B-215 Vau	Home Depot	$11.46	$34.38
Rags	3	CUS63651652	C. Warehouse	$21.71	$65.13
Screw driver set with bits	3	360-658	Home Depot	$5.97	$17.91
SDS bit set	1	DW5347	Acme	$38.21	$38.21
SDS hammer drill (roto)	1	DW563K	Acme	$199.05	$199.05
Small sledge, 4 LB	3	30-570 Un	Acme	$11.67	$35.01
Socket set	3	880-974	Home Depot	$37.02	$111.06
Square, 12"	3	731-528	Home Depot	$3.97	$11.91
Stepladder, 6 ft.	3	718-908	Home Depot	$39.02	$117.06
Studfinder	3	214-671	Home Depot	$29.94	$89.82
Tool bucket buddy	3	721-631C	Home Depot	$7.01	$21.03
Vise grips	3	232-092	Home Depot	$12.84	$38.52
		subtotal			$2,247.79
		Sales tax @8.6%			$193.31
		Total			**$2,441.10**

Working with Volunteers

Identifying Volunteers

Volunteers may be business partners, parents, and members of church organizations, local business employees, community groups, Habitat for Humanity or other civic groups. Volunteers participating in the school program mainly included District staff

working after hours, the nonstructural materials vendor, parents, university students, and American Red Cross personnel.

Volunteer Tasks
The Seattle School District nonstructural protection program did not use volunteers to inventory school spaces. First, the District's Core Mitigation Inventory team enabled nonstructural hazards to be identified in a consistent manner and enabled the district to coordinate work orders and purchasing with site visits. Second, some building staff was not comfortable with volunteers assessing the safety in their classrooms. This is in part due to reluctance to having strangers on the school grounds and to a desire to control activities in their workspace.

The Seattle School District used volunteers mainly to help implement nonstructural protective measures during district supervised work parties.

Issues Concerning the Use of Volunteers
The District Site Coordinator identified tasks and scheduled volunteers. Ideally sufficient volunteers can be identified to enable protective measures to be implemented during a one-day work party.

Volunteers should receive basic safety training if they will be using tools or equipment. They should be supervised to ensure consistent installation of protective measures, to make technical advice readily available, and to oversee the presence of non-school employees on the school campus.

COSTS OF IMPLEMENTING PROTECTIVE MEASURES

The following table shows the implementation costs and installation times for two pilot schools. Types of nonstructural elements protected include computers (including server hubs), television sets, aquariums, bookshelves, file cabinets, microwaves, refrigerators and washers and dryers. District trades personnel will take care of larger elements, such as lighting systems and boilers. This is related to the complexity of the element and the need to use union trades.

The costs represent significant savings due to the generosity of a Project Impact partner WorkSafeTechnologies. For example, the material and installation cost for protective film to cover 34 windows was $2000, or $3.50 – $4 per square foot. Districts may be able to negotiate savings due to bulk orders and for the completion of model school sites.

School Information	School Name	
	Lawton Elementary School	**Mercer Middle School**
Date Constructed	1991	1957
Student Enrollment	390	823
Gross square footage	54,986	123,182
Project Cost	**$3,800**	**$11,184**
		Labor
Inventory Assessment District Staff (2 @ 8 Hrs)		16
Custodial	9	16
Administrative	14	21
Team Leaders (2 @ 16 hrs)		32
Volunteers	32 (8 @ 4 hrs)	36 (6 @ 6 hrs)
Total	**55 hours**	**121 hours**

SUSTAINING THE NONSTRUCTURAL PROTECTION PROGRAM

The Seattle Public Schools risk management, logistics (Site Coordination), custodial, and the maintenance departments will work together to continue the success of this pilot project. This includes providing additional staff time and training to assist schools with work parties. This project requires the community and district involvement for continued success.

The safety of the students and staff are of great importance to the Seattle Public Schools. A safe environment is a necessary part of a good learning environment. Sustaining the nonstructural protection program requires a conscious effort to make the school community aware and concerned about nonstructural earthquake-induced damage to school sites. Damage to nonstructural elements is capable of injuring building occupants and destroying school property.

Integrating nonstructural protection into existing safety, maintenance, construction, and building programs is necessary to sustain program activities. Opportunities to incorporate nonstructural protective measures include:

- Purchasing criteria that will provide solid furnishings and equipment to better resist earthquake-induced damage
- Installation requirements for new equipment, such as emergency generators, that secure equipment against earthquake forces
- New construction and remodeling designs, which often do not address the protection of nonstructural elements;

- Coordination with other upgrades to reduce costs, such as securing recessed lights when the sprinkler system is upgraded;
- Determination of risk retention and risk transfer mechanisms to estimate potential cash required to resume school operations following a major earthquake; and
- Preparation of emergency operations and recovery plans to include earthquake contingency and redevelopment plans.

REVISED SECTION B

INVENTORY FORMS AND PROCESS

INVENTORY FORMS

INTRODUCTION

Duplicates of the inventory forms in Section B are provided with this guide. These copies can be included in a District Training Packet. This will enable each district to add additional information to tailor the training packet to meet individual district needs and requirements. Copies of the inventory forms can be provided to district staff who will be completing building inventories. District staff involved in the nonstructural protection program typically include maintenance and facilities staff. The District Manager should have the responsibility of maintaining a record of completed inventories, including those completed by school Site Teams.

A building Nonstructural Safety Binder should be maintained at each school site. Either the duplicates of the inventory forms that accompany this guide, copies provided by the district, or copies made from the guide may be kept in the school binder to be used as a master set of inventory forms. Site Teams can make copies from the inventory forms kept in the building binder to inventory building spaces. Completed forms can be filed in the building binder. District staff can check the building binder to see what has been completed. Other building information that can help Site Teams complete the nonstructural inventory may also be kept in the building binder. Site Teams typically include administrators, teachers, custodians, parents, and community volunteers. District staff may work with the Site Team.

Occupancy Types

Inventory forms have been developed for five occupancy types:

- Normal (Classrooms, Offices, Libraries);
- Assembly (Multi-Purpose Rooms, Halls, Stairwells, Exits, Gymnasiums, Auditoriums);
- Special Use (Kitchens, Shops, Art Rooms, Science and Computer Laboratories, Pool Rooms);
- Support (Utility Rooms, Mechanical Rooms, Storage Rooms, Penthouses); and
- Exterior Spaces (roof, external walls, exits, utility connections).

Each of these occupancies have some nonstructural elements in common and some that are specific to the occupancy type. Common elements are repeated on each form to allow all inventory information for a particular area to be entered onto one form.

Level 1 and Level 2 Inventory

The Level 1 inventory is designed for individuals with no knowledge of building systems, construction practice or architecture. Level 1 focuses on identifying the presence and number of selected nonstructural elements located in Normal, Assembly, and Special Use occupancies. A Level 1 inventory does not include using a ladder to access nonstructural elements, such as ceiling systems, or using judgement to evaluate the quality of attachments that appear to secure nonstructural elements. Level 1 does not include the inventory of Support Occupancies or Exterior spaces. Site Team members will usually complete a Level 1 inventory.

The Level 2 inventory includes identifying the presence and number of nonstructural elements in any occupancy, the evaluation of the quality of attachments that appear to secure nonstructural elements, and the determination of the need for structural engineering, architectural, or contracting services. Individuals completing a Level 2 inventory are usually custodial, maintenance, or facilities staff who are familiar with the building and with construction practice. Some volunteers may have sufficient skills to complete a Level 2 inventory, but should be supervised by district staff, complete safety training, and use proper safety equipment. The District should consider actions to best manage legal exposure if volunteers are used to complete a Level 2 inventory.

INVENTORY PROCESS

The Nonstructural Protection Guide primarily focuses on efforts to improve the safety of building occupants. The large number and variety of nonstructural elements in a school building makes the protection of all nonstructural elements from earthquake-induced damage expensive and unnecessary. Time and money spent completing extensive, detailed inventories of nonstructural elements could be better applied to protecting those elements of greater concern.

Setting the goals and objectives

A school district needs to set program goals and objectives beyond basic life safety to protect both building occupants and district investments. There are many nonstructural elements in a school building. Decide what occupancies and what elements will be included in the inventory. Take the building in steps.

The following is just an example of elements and spaces that the district may want to include in the inventory. A district may want to add additional elements and spaces or reduce the number shown below. The inventory and installation of protective measures for these elements may be carried out in phases.

- Desktop Computers
  Computers in libraries and offices may be a high priority because they often contain essential administrative data
  - Financially: desktop computers represent a large investment that if destroyed may not be covered by insurance due to high insurance deductibles
  - Life safety risk if located over students' heads, such as often occurs in libraries
- Overhead TV's and audio carts
  Overhead TV's will normally be secured on a platform attached to the wall. Reinforcement to the wall and to the platform increases safety
  Quake mats can be placed on VCR's to reduce flying objects and damage
  TV's need to be attached to audio visual carts for basic life safety.
- File cabinets and tall shelving
  File cabinets and tall shelving are likely to overturn if not secured. If located near an entrance they may prevent evacuation. Either remove to a safer location or secure to wall stud.
- Refrigerators and vending machines
  Need to be secured to avoid tipping and crushing building occupants.

Strengthening architectural systems, such as recessed lighting and exterior cladding, is generally included in building remodel plans. Inventory and assessment of these systems will be completed by district staff.

Completing the inventory

The inventory of building spaces is most efficiently completed by a district core team. The core team may include custodial and maintenance staff, the site coordinator, and other district staff. The core team becomes increasingly proficient with experience. The core team encourages building staff, parents, and other volunteers to help in the inventory process and oversees their activities.

Training requirements and tools:

- Training should be provided by the school district.
- Tools should be provided by the school district.
- School personnel set program goals and objectives and supervise program activities.

Preparing a work plan:

The work plan should indicate

- The location, the type and the number of nonstructural element(s) to be protected
- Who is responsible for implementing the protective measure
- A list protective options, including Good House Keeping, installation of restraints, and the relocation or removal of elements.

1. CLASSROOMS, OFFICES, AND LIBRARY SPACES

Name of school:	Building:
Date of inventory	Room number (if not numbered, enter the name of the space inventoried):

Circle level of inventory: **Level 1 Level 2**	**Enter your Name:**	**Item Present**		**Quantity**	**Comment**	**Date**
		Yes	**No**	**How Many?**	**M = Move A = Anchor**	**Fixed**
Desk-Top and Counter-Top Equipment						
Computer Monitors (Detail 6.1)						
CPU (Detail 6.1)						
Paper Cutter (Detail 6.1)						
Printer (Detail 6.1)						
Microwave (Detail 6.1)						
Aquariums, terrariums, animal cages (Detail 6.1)						
Tight electrical connections to computers or other electrical equipment (Detail 3.4).						
Furnishings and Equipment – Free Standing						
Tall file cabinet, storage cabinet, coat closet or card catalog, 4 feet (Detail 6.2; 6.3)						
Tall shelves over 4 feet (Detail 6.7)						
Refrigerator (Detail 6.5)						
Audio-visual cart with TV or other heavy equipment (Detail 6.10)						
Heavy modular partition walls separate office areas (Detail 11.3)						
Wall Mounted Items						
Heavy display cases, art work, fire extinguishers, (Detail 6.9)						
Cupboards (Detail 6.9)						
Lockers and cabinets (Detail 6.4)						
Glass panels, windows, or other panes of glass (Detail 7.1) (Level 2 only)						
Ceiling-height partition walls (Detail 11.1) (Level 2 only)						
Masonry partition walls (Detail 11.2) (Level 2 only)						
Dangerous Shelf Storage						
Heavy supplies and equipment (over 5 pounds)						
Cleaning or other chemicals (ammonia, bleach)						
Glass ware or other fragile items						

Level 1: Identify item and quantity; do not assess quality of attachments or use ladder to do inventory
Level 2: Identify item and quantity; assess quality of attachment and need for protective measures

Name of school:	Building:
Date of inventory	Room number (if not numbered, enter the name of the space inventoried):

Circle level of inventory: **Level 1 Level 2**	**Enter your Name:**	**Item Present**		**Quantity**	**Comment**	**Date**
		Yes	**No**	**How Many?**	**M = Move A = Anchor**	**Fixed**
Overhead Items						
Heavy hanging planters, art displays, office equipment located overhead						
Suspended ceilings (Detail 10.1, 10.2, and 10.3)						
Suspended light fixtures, air diffusers, and ventilation grills (Detail 10.4, 11.1)						
Pendant-mounted lights or double-hung fluorescent lights (Detail 10.5)						

Comments

Emergency Supplies, Equipment, And Information

Yes	No	
		School emergency procedures are posted in each classroom, office, and library.
		Earthquake drop, cover, and hold drills are practiced.
		There are sufficient emergency supplies for each member in the classroom, office, or library (first aid supplies, water, space blankets, battery operated radio, food, flashlight or candle sticks)
		A list of student names and home emergency contact information (name of emergency contact and telephone number) is kept current for each classroom. Consider adding this information to student identification cards.
		A list of staff names and home emergency contact information (name of emergency contact and telephone number) is kept current, including main office staff, school nurse, etc.)

Level 1: Identify item and quantity; do not assess quality of attachments or use ladder to do inventory
Level 2: Identify item and quantity; assess quality of attachment and need for protective measures

2. MULTI-PURPOSE ROOMS, GYMNASIUMS, AUDITORIUMS, HALLS, STAIRWELLS

Name of school:	Building:
Date of inventory	Room number (if not numbered, enter the name of the space inventoried):

Circle Level of Inventory: Level 1 Level 2	Enter Your Name:	Item Present		Quantity	Comments	Date
		Yes	No	How Many?	M = move A = Anchor	Fixed
Desk-Top and Counter-Top Equipment						
Furnishings and Equipment – Free Standing						
Vending machines, refrigerators, and freezers. Enter combined number of units (Details 6.5, 6.8)						
Audio-visual cart with TV or other heavy equipment (Detail 6.10)						
Tall shelves over 4 feet (Detail 6.7)						
Piano without locked wheels (Detail 6.10)						
Folding tables or bleachers on wheels (Detail 16.10)						
Tall, heavy gym apparatus						
Wall Mounted Items						
Emergency lights						
Television set						
Fire extinguishers on open hooks or in recessed wall cupboards (Detail 6.9)						
Heavy speakers and spotlights						
Heavy display cases and art work (Detail 6.9)						
Folding wall dividers						
Wall cupboards (Detail 6.9)						
Lockers, cabinets, and coat closets (Detail 6.4)						
Display case glass, windows, or door panes of glass (Detail 7.1)						
Ceiling-height partition walls (Detail 11.1)						
Masonry partition walls (Detail 11.2)						
Stairways						
Dangerous Shelf Storage						
Heavy supplies, equipment, emergency battery operated light units (over 5 pounds)						

Level 1: Identify item and quantity; do not assess quality of attachments or use ladder to do inventory
Level 2: Identify item and quantity; assess quality of attachment and need for protective measures

Name of school:	Building:
Date of inventory	Room number (if not numbered, enter the name of the space inventoried):

Circle Level of Inventory: Level 1 Level 2	Enter Your Name:	Item Present Yes	No	Quantity How Many?	Comments M = move A = Anchor	Date Fixed
Cleaning or other chemicals (ammonia, bleach)						
Glass ware, stacks of glass plates or other fragile items						
Overhead Items						
Heavy hanging planters or other decorative objects (sitting or standing)						
Skylight glass panels (Detail 7.1)				Sq. Ft.		
Suspended ceilings (Detail 10.1, 10.2, and 10.3)				Sq. Ft		
Suspended light fixtures, air diffusers, and ventilation grills (Detail 10.4, 11.1)						
Pendant-mounted lights or double-hung fluorescent lights (Detail 10.5)						
Cable tray supports (Detail 3.1)				Lineal Ft.		
Suspended space heaters (Detail 10.7)						
Suspended piping				Lineal Ft.:		
Comments:						

Emergency Supplies, Equipment, And Information

Yes	No	
		School emergency procedures are posted .
		Building floor plans showing evacuation routes are posted
		Building floor plans are kept up-to-date
		Earthquake drop, cover, and hold drills are practiced.
		Public address system is connected to emergency power
		Exits are clearly marked
		Capability exists to provide on-site shelter

Level 1: Identify item and quantity; do not assess quality of attachments or use ladder to do inventory
Level 2: Identify item and quantity; assess quality of attachment and need for protective measures

3. KITCHENS, SHOPS, ART ROOMS, SCIENCE, AND COMPUTER LABORATORIES, AND POOL ROOMS

Name of school:	Building:
Date of inventory	Room number (if not numbered, enter the name of the space inventoried):

Circle level of inventory: Level 1 Level 2	Enter Your Name	Item Present		Quantity	Comment	Date
		Yes	No	How Many?	M = Move A = Anchor	Fixed
Desk-Top and Counter-Top Equipment						
Microscope						
Computer Monitor (Detail 6.1)						
CPU (Detail 6.1)						
Aquariums, terrariums, animal cages (Detail 6.1)						
Microwave (Detail 6.1)						
Small counter-top refrigerator						
Electrical connections to equipment :						
Furnishings and Equipment – Free Standing						
Compressed gas cylinder (Detail 8.2)						
Audio-visual cart with TV or other heavy equipment (Detail 6.10)						
Chemical supply cart on wheels (Detail 6.10)						
File cabinets (Detail 6.2)						
Vending machines, refrigerators, and freezers. Enter combined number of units (Details 6.5, 6.8)						
Tall shelves over 4 feet (Detail 6.7)						
Water heater in kitchen area (Detail 9.7)					X	
Gas-fired kitchen or lab equipment					X	
Laboratory benches and counters						
Laboratory fume hoods						
Raised access floor (Detail 2.1)						
Kiln						
Tall, heavy shop equipment, table saws, drill presses (Detail 6.1)						
Pool filtration tanks (Detail 9.1)						
Wall Mounted Items						
Television set						
Fire extinguishers (Detail 6.9)						
Wall cupboards (Detail 6.9)						

Level 1: Identify item and quantity; do not assess quality of attachments or use ladder to do inventory
Level 2: Identify item and quantity; assess quality of attachment and need for protective measures

Name of school:	Building:
Date of inventory	Room number (if not numbered, enter the name of the space inventoried):

Circle level of inventory: Level 1 Level 2	Enter Your Name	Item Present		Quantity	Comment	Date
		Yes	No	How Many?	M = Move A = Anchor	Fixed
Cupboard doors (Detail 6.9)						
Heavy display cases and art work (Detail 6.9)						
Lockers, cabinets, and coat closets (Detail 6.4)						
Display case glass, windows, or door panes of glass (Detail 7.1)						
Ceiling-height partition walls (Detail 11.1)						
Masonry partition walls (Detail 11.2)						
Dangerous Shelf Storage						
Chemical supplies (Detail 8.1)						
Items over 5 pounds)						
Glass ware, stacks of glass plates and other heavy or fragile items						
Overhead Items						
Heavy hanging planters or other decorative objects (sitting or standing)						
Suspended ceilings (Detail 10.1, 10.2, and 10.3)				Sq. Ft.		
Suspended light fixtures, air diffusers, and ventilation grills (Detail 10.4, 11.1)						
Pendant-mounted lights or double-hung fluorescent lights (Detail 10.5)						
Cable tray supports (Detail 3.1)						
Suspended space heaters (Detail 10.7)						
Suspended air condition unit (Detail 9.5)						
Suspended piping						

Comments

Level 1: Identify item and quantity; do not assess quality of attachments or use ladder to do inventory
Level 2: Identify item and quantity; assess quality of attachment and need for protective measures

Emergency Supplies, Equipment, And Information

Yes	No	
		Automatic gas or electricity shut-offs are installed on shop and laboratory equipment
		Manual gas and electricity shut-off information and key to room shut-off valve available
		Staff and students are trained to move away from dangerous areas during earthquakes
		Spill control and clean-up materials are keppt in science laboratories, pool rooms, and other areas where hazardous materials are stored.
		Area specific emergency procedures are posted, including emergency contacts and phone numbers
		An updated inventory is maintained of all chemicals on site.
		Material Supply Data (MSD) inventory of chemicals is posted
		Telephone number of nearest burn center and poison center is posted.

Level 1: Identify item and quantity; do not assess quality of attachments or use ladder to do inventory
Level 2: Identify item and quantity; assess quality of attachment and need for protective measures

4. UTILITY ROOMS, MECHANICAL ROOMS, STORAGE ROOMS, BATH ROOMS, AND PENTHOUSES

Name of school:	Building:
Date of inventory	Room number (if not numbered, enter the name of the space inventoried):

Circle level of inventory: Level 1 Level 2	Enter your name:	Item Present		Quantity	Comments	Date
		Yes	No	How Many?	M = Move A = Anchor	Fixed
Desk-Top and Counter-Top Equipment						
Computer Monitor and test equipment (Detail 6.1)						
CPU (Detail 6.1)						
Electrical connections to equipment :						
Furnishings and Equipment – Free Standing						
Wheeled cart or small table for communication system monitor or other test equipment (Detail 6.10)						
Water heater (Detail 9.7)						
Gas-fired boiler						
Gas furnace						
Emergency power system (Detail 3.3)						
Emergency power system battery sets (Detail 3.3)						
Transformer						
Sprinkler system riser (Detail 6.3)						
Water pump (Detail 6.3)						
Wall Mounted Items						
Fire extinguishers (Detail 6.9)						
Electrical Panel						
Plumbing Fixtures - flush tanks						
Water storage – day tank						
Masonry partition walls (Detail 11.2)						
Dangerous Shelf Storage						
Cleaning chemical (ammonia and bleach) (Detail 8.1)						
Heavy items						
Overhead Items						
Suspended ceilings (Detail 10.1, 10.2, and 10.3)				Sq. Ft.		
Suspended light fixtures, air diffusers, and ventilation grills (Detail 10.4, 11.1)						

Level 1: Identify item and quantity; do not assess quality of attachments or use ladder to do inventory
Level 2: Identify item and quantity; assess quality of attachments and need for protective measures

Name of school:	Building:
Date of inventory	Room number (if not numbered, enter the name of the space inventoried):

Circle level of inventory: Level 1 Level 2	Enter your name:	Item Present		Quantity	Comments	Date
		Yes	No	How Many?	M = Move A = Anchor	Fixed
Pendant-mounted lights or double-hung fluorescent lights (Detail 10.5)						
Water distribution pipes						
Cable tray supports (Detail 3.1)						
Suspended space heaters (Detail 10.7)						
Suspended air condition unit (Detail 9.5)						
Suspended duct system						

Comments

Emergency Supplies, Equipment, And Information

Yes	No	
		Flashlights are available in each room
		Automatic gas shut-off is installed on gas-fired equipment
		Gas, electricity, and water shut-off information is posted
		Tools to turn off utilities are easily accessible
		Several staff members know how to turn off utilities..
		Area specific emergency procedures are posted, including emergency contacts and phone numbers

Level 1: Identify item and quantity; do not assess quality of attachments or use ladder to do inventory
Level 2: Identify item and quantity; assess quality of attachments and need for protective measures

5. BUILDING EXTERIOR

Name of school:	Building:
Date of inventory	Room number (if not numbered, enter the name of the space inventoried):

Circle level of Inventory:	Enter Your Name:	Item Present		Quantity	Comments M = Move A = Anchor	Date Fixed
		Yes	No	How Many?		
Roof						
Masonry chimney (Detail 6.1)						
Masonry parapet walls						
Masonry cornices						
HVAC units (Detail 6.1)						
Exterior Walls						
Masonry or concrete wall to floor connection						
Building entrances						
Heavy wall decorations						
Adjacent to building						
Vending machines						
Building canopies and covered walkways						
Gas Service						
Natural gas meter						
Gas distribution piping						
Automatic gas shut-off valve						
Electrical Service						
Overhead wires (Detail 3.4)						
Site transformer						

General Comments

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Level 1: Identify item and quantity; do not assess quality of attachment, use ladder, or go onto roof
Level 2: Identify item and quantity; assess quality of attachment and need for protective measures

Emergency Supplies, Equipment, And Information

Yes	No	
		A survey of the on-site gas distribution system has been completed. While in some instances an automatic shut-off valve on the main gas meter may be an effective measure to reduce potential gas leaks, such a valve may be ineffective in some circumstances. Other actions may provide better protection from potential gas hazards. The variation in gas system characteristics from building to building makes a generic recommendation inappropriate.
		A grounds program is in place that addresses vegetation hazards, such as fragile trees that could overturn and cause building damage or damage to electrical service, excessive vegetation that could prevent access to and observation of areas near school buildings or generate fire hazards.
		The nearest pay phone has been identified in case on-site service does not function. Pay phones may function when on-site service does not. Test internal phone system to determine if service is delayed or not available by blowing into the speaker. If noise is heard in the earpiece, the system is delayed rather than out of order. If this is an emergency, do not hang-up or click the connection, as that will place you at the end of the cue.